Action Crisis

A Critical Phase in Goal Striving

Thesis (cumulative thesis)

Presented to the Faculty of Arts and Social Sciences

of the University of Zurich

for the Degree of Doctor of Philosophy

by Marcel Herrmann

Accepted in the Autumn Term 2013

on the Recommendation of the Doctoral Committee

Prof. Dr. Veronika Brandstätter-Morawietz (main advisor)

Prof. Dr. Carsten Wrosch

Zürich, 2013

Artikel 1: Herrmann, M., & Brandstätter, V. (2013). Overcoming action crises in personal goals – Longitudinal evidence on a mediating mechanism between action orientation and well-being. *Journal of Research in Personality*, *47*(6), 881-893. doi: http://dx.doi.org/10.1016/j.jrp.2013.09.005

Artikel 2: Brandstätter, V., Herrmann, M., & Schüler, J. (2013). The struggle of giving up personal goals - Affective, physiological, and cognitive consequences of an action crisis. *Personality and Social Psychology Bulletin*, *39*(12), 1668-1682. doi: http://dx.doi.org/10.1177/0146167213500151

Artikel 3: Herrmann, M., Baur, V., Brandstätter, V., Hänggi, J., & Jäncke, L. (2013). *Being in two minds - The neural basis of experiencing action crises in personal long-term goals.* Manuscript submitted for publication.

Artikel 4: Herrmann, M., & Brandstätter, V. (2013). *Cognitive tuning among personal goals - Action crises and goal-independent cognition.* Manuscript submitted for publication.

Being in Two Minds – The Neural Basis of Experiencing Action Crises in Personal Long-Term Goals

Marcel Herrmann, Volker Baur*, Veronika Brandstätter, Jürgen Hänggi, and Lutz Jäncke*

Author Note

*contributed equally to this work

Marcel Herrmann and Veronika Brandstätter, Department of Psychology, Psychology of Motivation, Volition and Emotion, University of Zurich, Switzerland. Volker Bauer, Department of Psychology, Division Neuropsychology, University of Zurich, Switzerland, and Department of Psychiatry and Psychotherapy, University Hospital Zurich, Switzerland. Jürgen Hänggi, Department of Psychology, Division Neuropsychology, University of Zurich, Switzerland. Lutz Jäncke Department of Psychology, Division Neuropsychology, University of Zurich, Switzerland, and International Normal Aging and Plasticity imaging Center, University of Zurich, Switzerland, and Center for Integrative Human Physiology, University of Zurich, Switzerland.

This research was supported by a grant of the Swiss National Science Foundation (SNSF) to Veronika Brandstätter (100014_130131) and a grant of the University of Zürich, Switzerland, to Lutz Jäncke. The SNSF had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. All authors declare no conflict of interest.

Abstract

Although the successful pursuit of long-term goals constitutes an essential prerequisite to personal development, health and well-being, little research has been devoted to the understanding of its underlying neural processes. A critical phase in the pursuit of long-term goals is defined as an *action crisis*, conceptualized as the intra-psychic conflict between further goal pursuit and disengagement from the goal. In the present research, we applied an interdisciplinary (cognitive and neural) approach to the analysis of processes underlying the experience of an action crisis. In Study 1, a longitudinal field study, action crises in personal goals gave rise to an increased and unbiased (re)evaluation of the costs and benefits (i.e., *rewards*) of the goal. Study 2 was a magnetic resonance imaging study examining resting-state functional connectivity. The extent of experienced action crises was associated with enhanced fronto-accumbal connectivity signifying increased *reward*-related impact on prefrontal action control. Action crises, furthermore, mediated the relationship between a dispositional measure of effective goal pursuit (action orientation) and fronto-accumbal connectivity. The converging and complementary results from two methodologically different approaches advance the understanding of the neurobiology of personal long-term goals, especially with respect to the role of rewards in the context of goal-related conflicts.

Keywords: long-term goals; action crisis; action orientation; resting-state functional connectivity; nucleus accumbens

Introduction

"Humans beings are, by nature, goal-oriented organisms" (Emmons, 1996, p. 314). Meaningful (i.e., non-reflexive and non-accidental) human behavior, almost without exception, has its origins in long-term goals (e.g., becoming a professional sportsman) that, by giving life structure and purpose, substantially contribute to an individual's sense of fulfillment and well-being. However, despite the theoretical and practical relevance of the concept, "neuroscientists have yet to examine long-term goals" (Berkman & Lieberman, 2009, p. 104). Previous neuroscientific research has focused exclusively on separate goal-related (sub)processes or short-term goals. This is mainly attributable to the current method in functional magnetic resonance imaging (fMRI) research of analyzing goal-related cognitive processes task-based, i.e., in the context of experimentally induced tasks lasting seconds or minutes. As a consequence, interdisciplinary research that, in the realm of idiographic (i.e., everyday life) long-term goals, links neuroscientific to cognitive-behavioral data is lacking (cf. Berkman & Lieberman, 2009).

In the present research, we therefore applied an interdisciplinary and multi-methodological approach to the analysis of long-term goals, more precisely, the examination of cognitive and neural processes associated with an *action crisis*. An action crisis is conceptualized as the critical phase in the pursuit of long-term goals in which individuals, as a consequence of a loss of goal attainability (e.g., due to repeated setbacks) and/or desirability, become caught (in the decision) between further goal pursuit and disengagement from the goal (Brandstätter, Herrmann, & Schüler, in press; Brandstätter & Schüler, 2013). Even though a goal has long been implemented and is being actively pursued, a goal is *re*-evaluated and weighed up against potential alternatives. Thus, in an action crisis, an individual, in the course of goal pursuit, becomes preoccupied with an *additional task* characteristic of goal setting (i.e., the *pre*decisional phase that precedes goal pursuit). An

action crisis, therefore, includes *doing the splits* between a volitional (goal striving) and a motivational (goal setting) task while the way of processing information is not ideally tuned to either of them (cf. cognitive tuning; Gollwitzer, Heckhausen, & Steller, 1990). Whereas volitional processes, e.g., are facilitated by *selectively* analyzing and *partially* evaluating information that is relevant to the focal goal, motivational processes benefit from *objectivity* and *impartiality*, essential prerequisites to rational decision-making (cf. mindset theory; Gollwitzer, 2012). An action crisis, however, not merely results in a competition for resources between the cognitively conflicting tasks of *striving* for the focal goal ("how" level) and *re-evaluating* it ("why" level; Trope & Liberman, 2010), but between the focal goal and potential alternatives that become more salient in an action crisis (Shah, Friedman, & Kruglanski, 2002). As a consequence of *being in two minds*, and consistent with the idea that the reconsideration of alternative goals undermines goal commitment and the development of effective means (Shah & Kruglanski, 2002), individuals in an action crisis have been shown to suffer from impaired goal progress. Furthermore, as personal goals constitute an individual's self-concept and self-value, action crises, especially in highly self-relevant goals, pose a serious threat to health and well-being (Brandstätter et al., in press).

An action crisis thus represents a critical phase in goal striving that typically precedes but not necessarily leads to goal disengagement. Especially with self-relevant long-term goals, goal disengagement does not represent a discrete event but, as "the self is partly made up of the person's goals" (Carver & Scheier, 2005, p. 528), results from a lengthy and difficult process (Klinger, 1977). The present research, by applying the concept of an action crisis, attempts to delineate the cognitive (Study 1) and neural (Study 2) characteristics of these goal disengagement processes in everyday life. Goal disengagement, although highly relevant to self-regulation, has, until recently, received almost no attention (Brandtstädter, 2007; Carver & Scheier, 1998; Wrosch et al., 2003). A process-based perspective on long-

term goals, furthermore, has been subject merely to theoretical considerations (Klinger, 1977).

In Study 1, as a first step (*quantitative aspect*), we analyzed, in a longitudinal field study, the long-term consequences of an action crisis on the re-consideration of goal-related costs and benefits (i.e., goal-related rewards), which should be emphasized following the experience of an action crisis (hypothesis 1). As a second step (*qualitative aspect*), drawing on Brandstätter and Schüler (2013), we tested whether an action crisis, to some extent, counteracts *goal shielding*, which may be defined as self-regulatory processes enhancing the value of the focal goal (e.g., in comparisons with potential alternatives) in the course of goal pursuit (Achtziger, Gollwitzer, & Sheeran, 2008; Shah et al., 2002). Because an action crisis represents a decision-making process, which benefits from open-mindedness, it was hypothesized that goal (re)evaluation in an action crisis is not biased in favor of the goal. Pros and cons of a goal were assumed to be deliberated equally in an action crisis (hypothesis 2).

Study 2 was an fMRI study conducted to determine *neural* correlates of an action crisis. The identification of changes in neural connectivity patterns between regions responsible for action control and motivation (i.e., goal-related rewards) should substantiate the construct of an action crisis, deepen the understanding of its underlying mechanisms and consequences, and contribute to the understanding of the neurobiological basis of motivational processes in the pursuit of long-term goals.

To test our hypotheses, we pursued a *nomothetic-idiographic* approach to personal goals (Brunstein, 1993; Emmons, 1986). For the purpose of measurement accuracy and in order to capture the “nucleus” of an individual’s goal system, participants had to list their primary *idiographic* long-term goals that had to be assessed in relation to *nomothetic* variables (i.e., action crisis). Nomothetic variables were averaged across personal goals for statistical analyses.

Statistical analyses. Cross-lagged path and mediation analyses were performed using AMOS® (version 20), regression analyses and correlations were calculated with SPSS® (version 20; IBM® SPSS® Statistics Inc., Armonk, NY). Bootstrap estimates in mediation analyses were based on 1000 bootstrap samples.

Study 1

In Study 1, goal (re)evaluation, which was assumed to become pronounced in an action crisis (hypothesis 1), was operationalized by the frequency with which participants deliberated on the costs and benefits of goal disengagement and further goal pursuit, respectively. Whereas assigned *post*decisional deliberation on a goal, in the absence of an action crisis, has been shown to result in a "defensive focus on the pros of goal pursuit" (Nenkov & Gollwitzer, 2012, p. 117), i.e., goal shielding, an action crisis was hypothesized to lead to *unbiased* cost-benefit thinking (hypothesis 2). The hypothesized directionality in the relationship between action crisis and cost-benefit thinking was tested with cross-lagged panel analyses (Kenny & Harackiewicz, 1979).

The manuscript is partly based on data previously used in a published report concerning goal-relevant resources (Schnelle, Brandstätter, & Knöpfel, 2010). The present findings have no overlap with previously reported data.

Method

Participants and procedures. A sample of 283 (228 women) students (M_{age} = 23.5 years, SD_{age} = 6.58 years) completed a questionnaire at time point 1 (T1) at the beginning and a web-based questionnaire at time point 2 (T2) at the end of the semester (14 weeks later).

Personal goals. At T1, participants had to define four personally relevant long-term goals, two academic and two leisure goals.

Action crisis. Action crises were assessed with the Action Crisis Scale (ACRISS; Brandstätter & Schüler, 2013; see Supplementary material, Section A).

Cost-benefit thinking Participants, at T1 and T2, indicated the frequency with which they had recently thought about the costs (CC) and benefits of continuing (BC) as well as the costs (CD) and benefits of disengaging (BD) from the goal (Brandstätter & Schüler, 2013). By averaging BC and CD, we compiled an index of the deliberation intensity of the pros of the goal (i.e., deliberation in favor of further goal pursuit). Analogously, CC and BD were used as an index of the deliberation intensity of the cons of the goal (i.e., deliberation in favor of goal disengagement) (see Supplementary material, Section A).

Results

Means (SDs) and zero-order correlations between the continuous study variables are reported and discussed in the Supplementary material (Section B).

To obtain evidence regarding the directionality in the relationship between action crises and cost-benefit thinking, i.e., whether an action crisis precedes increased cost-benefit thinking, we conducted cross-lagged panel analyses (Kenny & Harackiewicz, 1979). For detailed information on the statistical analyses, see Supplementary material (Section C).

Hypothesis 1 could be confirmed in the full cross-lagged path model (see Supplementary Figure 1) and, subsequently, the theoretically driven *Model 1*, which had excellent indices of fit (see Figure 1). (For reasons of clarity, in the following, the deliberation intensity of the pros of the goal, i.e., deliberation in favor of further goal pursuit, is abbreviated as *goal pursuit* whereas the deliberation intensity of the cons of a goal is abbreviated as *goal disengagement*.) Completely in line with hypothesis 1, an action crisis was longitudinally associated with an increase in cost-benefit thinking.

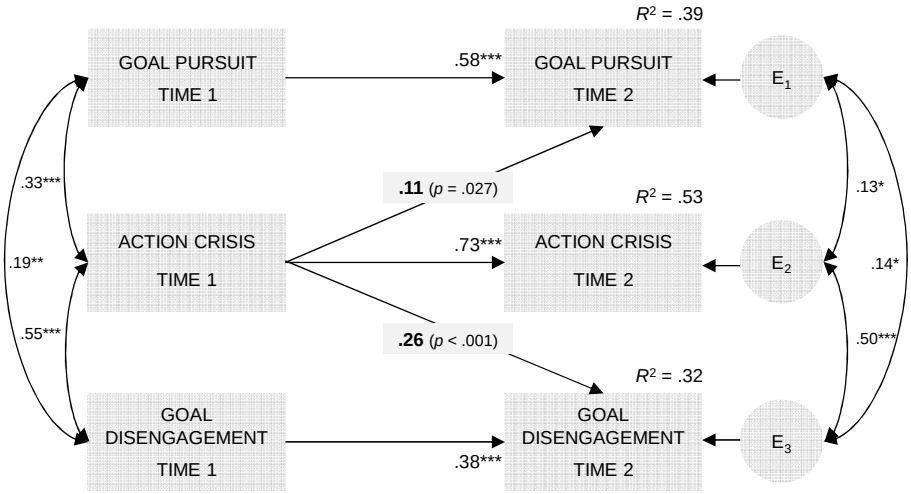


Figure 1. Cross-lagged path model for the prediction of cost-benefit thinking at T2 from action crisis (averaged over all goals) at T1 [$X^2(4) = 4.870$, $p = .301$, $X^2/df = 1.217$, *NNFI* = .995, *CFI* = .999, *RMSEA* = .028 (C.I. .000-.098; PCLOSE = .609)] (Study 1). *Note*. GOAL PURSUIT = deliberation intensity of the pros of the goal, i.e., in favor of further goal pursuit; GOAL DISENGAGEMENT = deliberation intensity of the cons of the goal, i.e., in favor of goal disengagement. Squares indicate observed variables. A circle indicates a residual error in the prediction of an observed variable. Single-headed arrows represent regression paths. Double-headed arrows represent synchronous correlations. Above endogenous observed variables, R^2 indicates the total amount of explained variance. Regression paths not considered in the model did not reached significance in the full cross-lagged path model (see Supplementary Figure 1) and were excluded in the final model. Correlation coefficients are statistically significant at $*p < .05$, $**p < .01$, and $***p < .001$. For regression paths, exact probabilities are reported. Standardized maximum-likelihood parameters are used.

To test hypothesis 2, we set the regression paths from action crises at T1 to goal pursuit and goal disengagement at T2 in *Model 1* to equality. Hence, the resultant (more parsimonious) *Model 2*, in accordance with hypothesis 2, specified the effects of an action crisis on the deliberation of the pros *and* cons of a goal as being equally strong. Because *Model 1* and *Model 2* did not differ significantly (ΔX^2 1.59, $df = 1$, $p = .207$), in which case the more parsimonious model is to be preferred, hypothesis 2 was supported by the model comparison. Therefore, the conclusion may be drawn that an action crisis does not merely give rise to an increased (re)consideration of a goal (hypothesis 1) but that this cost-benefit thinking is *unbiased* (hypothesis 2). An action crisis, thus, gives rise to a cognitive orientation that, to some extent, counteracts goal shielding.

Study 2

In continuation of Study 1, in which characteristics of an action crisis were explored on a *cognitive* level, Study 2 aimed at uncovering the *neural* activity pattern underlying changes in information processing (i.e., unbiased cost-benefit thinking) in an action crisis. Thereby, Study 2 represents a new approach to the analysis of the neurobiology of personal long-term goals (Berkman & Lieberman, 2009).

From a theoretical point of view, the conflict being characteristic of an action crisis (i.e., *doing the splits* between a motivational and a volitional task) may be adequately accounted for by the investigation of brain regions subserving action control (i.e., volition) and motivation (i.e., goal-related rewards). Whereas the prefrontal cortex instantiates a neural system for cognitive control and planning (i.e., volitional abilities relevant to the pursuit of long-term goals; Miller & Cohen, 2001; Tanji, Shima, & Mushiake, 2007), the nucleus accumbens (NAcc), part of the ventral striatum, is central to the brain's reward system and provides a link between motivationally relevant emotional processes (e.g., reward anticipation or subjective preferences) and action (Mogenson, Jones, & Yim, 1980). Importantly, the NAcc receives regulatory influences from the prefrontal cortex (Sesack & Grace, 2010).

In an action crisis, as a consequence of reduced (i.e., counterbalanced) goal shielding, (cf. Study 1), a goal should lose its predominance over competing alternatives, whereby an individual's behavior becomes more susceptible to incentives associated with alternative goals (Shah et al., 2002) as well as goal-irrelevant temptations (Förster & Denzler, 2009; Kruglanski et al., 2002). Therefore, from a neural perspective, an action crisis should re-instigate or interfere with prefrontal cortical self-control mechanisms crucial to future-oriented behavior, more precisely, the pursuit of *long-term* goals (Miller & Cohen, 2001; Tanji et al., 2007). Subcortical reward-related (*short-term* and *long-term*) impact on behavior,

consequently, should be increased. The pursuit of "long-term task goal[s]" (p. 1488) in the context of increased reward-related impact on action control has been examined in an fMRI study by Diekhof and Gruber (2010). Even though, in the respective study, the focus was on an experimentally induced and thus nomothetic goal, the results may be applicable to long-term goals and are therefore of importance to the present research.

Subjects were confronted with a "desire-reason dilemma" (Diekhof & Gruber, 2010, p. 1489) in which actions favoring the successful performance of a task goal ("reason") had to be preferred over immediately available rewards ("desire"). This specific experimental context was characterized by increased negative functional connectivity between left anteroventral prefrontal/lateral frontopolar cortex (FPC) and bilateral NAcc. In addition, interindividually, behavioral success in favoring the task outcome despite the presence of reward-related distractors (i.e., *effective* goal pursuit) was predicted by the extent of FPC-NAcc negative functional connectivity.

Because, in an action crisis, the influence of goal-related (cf. Study 1) as well as goal-independent incentives and temptations (Shah et al., 2002) on action control is assumed to be increased, the neurobiological findings reported by Diekhof and Gruber (2010) provide an excellent framework for the investigation of the neural basis of experiencing action crises in idiographic long-term goals. As, there, good task performance (i.e., high effectiveness of goal pursuit) was characterized by *decreased* fronto-accumbal connectivity, the opposite pattern was hypothesized to underlie the experience of an action crisis that has been shown to impair goal progress (low effectiveness of goal pursuit) (Brandstätter et al., in press). Thus, we expected increased positive or decreased negative functional connectivity between left FPC and NAcc to be associated with an action crisis (hypothesis 3).

Investigating goal-related processing in an action crisis in a brain imaging study is associated with considerable conceptual and methodological demands. First, an individual's

long-term goals exert pervasive influence on cognition and behavior, even outside awareness (e.g., Bargh et al., 2001), and an action crisis in a highly self-relevant goal (e.g., "Should I drop out of university?") typically lasts several months (cf. Study 1). An action crisis, therefore, is likely to become manifest in *intrinsic* brain properties, especially in light of research on procedural priming (cf. Förster, Liberman, & Friedman, 2009) which suggest that cognitive procedures, once activated, influence the way of information processing in subsequent tasks. Procedural priming effects have been shown to last several days (Smith, Stewart, & Buttram, 1992) and, importantly, to result from the experience of action crises (Herrmann & Brandstätter, 2013b). Second, an action crisis, by definition, represents a real-life phenomenon with high interindividual variance regarding the content of idiographic long-term goals. As a result, implementation in task-based fMRI appears inadequate (cf. Berkman & Lieberman, 2009).

As a consequence, an action crisis was mapped on the neural level in a *task-free* setting. "Resting-state" functional connectivity (rsFC) is defined as the degree of coupling between brain regions *in the absence of any task*, as reflected by the interregional coherence of the spontaneously changing signal measured during fMRI (Fox & Raichle, 2007). rsFC is considered to index intrinsic neuronal processes ("intrinsic connectivity") (Fox & Raichle, 2007), for example memory consolidation (Albert, Robertson, Mehta, & Miall, 2009; Wang, Liu, Li, & Zang, 2012). A growing literature adds to the fact that interindividual variability in rsFC accounts for aspects of personality and behavior (Kelly, Biswal, Craddock, Castellanos, & Milham, 2012). In the present research, rsFC was related to the extent to which individuals were currently experiencing action crises in personal goals.

As Diekhof and Gruber (2010) reported FPC-NAcc functional coupling to be *positively* associated with trait impulsivity, we expected trait-related, goal-relevant self-regulatory abilities (i.e., state versus action orientation; Kuhl, 1994b) to be *negatively* related

to fronto-accumbal coupling. Importantly, action orientation, the volitional ability to regulate basic affect (Baumann, Kaschel, & Kuhl, 2007), has been linked to prefrontal executive functions (Koole, 2004; Kuhl & Koole, 2004) and could be consistently identified as a predictor of effective goal pursuit (e.g., Baumann, Kaschel, & Kuhl, 2005; Brunstein, 1989, 2001; Kuhl, 1981, 1992, 1994b) and protective factor for the experience of action crises in personal goals (Herrmann & Brandstätter, 2013a). Therefore, we hypothesized action crises in personal goals to mediate the relationship between action orientation and fronto-accumbal decoupling. Action-oriented individuals, due to a reduced extent of experienced action crises, were assumed to show increased fronto-accumbal decoupling (hypothesis 4).

To complement our approach, we also analyzed fronto-accumbal structural connectivity. We found evidence that white matter integrity between left NAcc and left FPC is modulated by action orientation (see Supplementary material, Section H).

The manuscript is partly based on data previously used in a published report concerning relations between anxiety and connectivity in limbic pathways (Baur, Hänggi, Langer, & Jäncke, 2013).

Method

Participants and procedures. For magnetic fMRI, we analyzed data of 33 healthy participants (18 women, M_{age} = 24.9 years, SD_{age} = 4.57 years). None of the subjects was part of the dataset of Study 1. Questionnaires were sent to participants one week prior to the fMRI examination. For detailed information about the sample, exclusion criteria, ethics, psychometrics (e.g., control variables), and fMRI scanning, see Supplementary material (Sections D and E).

Personal goals. As in Study 1, participants were asked to state (three) personally relevant long-term goals from different areas of life they were currently striving for.

Action crisis. See Study 1.

Action orientation. Action orientation was assessed using the Action Control Scale (ACS-90; Kuhl, 1994a).

Regions of interest definition. Based on previous evidence (Diekhof & Gruber, 2010) and our theorizing on action crises, we focused on the left and right NAcc as well as the left FPC in an *a priori* regions-of-interest (ROI) approach (see Figure 2A). Connectivity was assessed between left NAcc and left FPC as well as between right NAcc and left FPC. For details regarding the definition of ROIs, see Supplementary material (Section E).

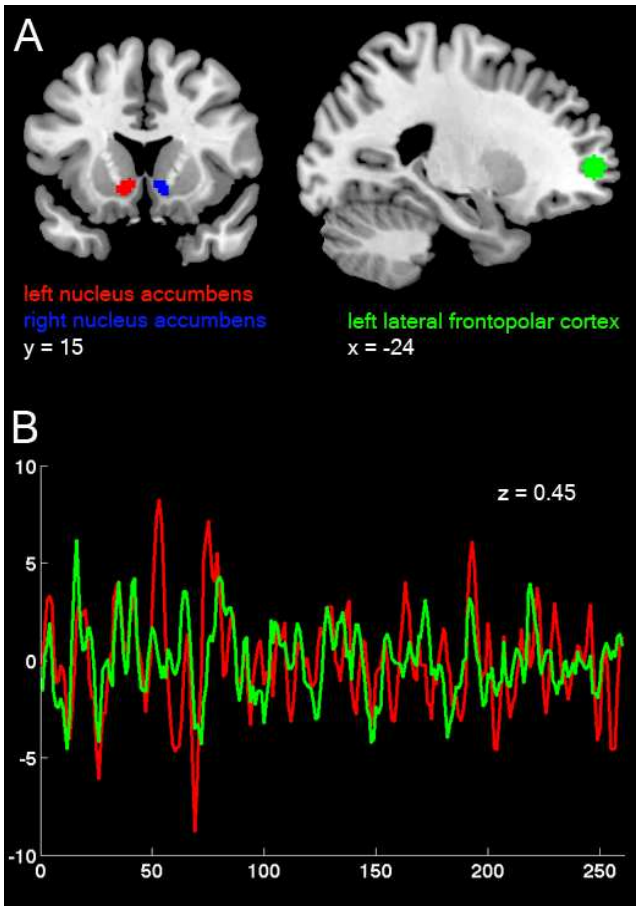


Figure 2. (A) Regions of interest, coronal (left) and sagittal (right) coordinates reported in Montreal Neurological Institute standard space. (B) Hemodynamic signal time course across 260 brain scans (corresponding to 10 min of resting-state functional magnetic resonance imaging) for left nucleus accumbens (red) and left lateral frontopolar cortex (green), respectively, exemplarily shown for one subject. The *z*-value represents the correlation between the two time courses.

Resting-state functional connectivity. Preprocessing was carried out with DPARSF toolbox (Chao-Gan & Yu-Feng, 2010) using functions of SPM 8 (www.fil.ion.ucl.ac.uk/spm/software/spm8) and is described in detail in Supplementary

material (Section E). Preprocessed fMRI data were subjected to REST toolbox 1.6 (Song et al., 2011) extracting the mean blood oxygenation level dependent signal time course for each ROI and for each subject. Next, signal time courses (exemplarily shown in Figure 2B) were cross-correlated between left respectively right NAcc and left FPC. Finally, correlations were *r*-to-*z*-transformed to improve normal distribution for group-level statistics. To complement ROI-based analyses, we also set an exploratory whole-brain approach. This comprised a seed-based analysis of rsFC of left and right NAcc, respectively (see Supplementary material, Section G). Using NAcc as seed is of interest and should yield valid results, as pointed out by a recent combined meta-analytic and rsFC study (Cauda et al., 2011).

Statistical analyses. FPC-NAcc rsFC, as represented by the *z*-value derived from the ROI analysis, was linked to the extent participants were experiencing action crises in personal goals using multiple regression analyses.

Results

Means (SDs) and zero-order correlations between the major study variables are reported in Supplementary material, Supplementary Table 2 (Section F).

Action crisis and functional connectivity. Completely in line with hypothesis 3, rsFC between frontal and accumbal ROIs, even after having controlled for action orientation and neuroticism, could be predicted by the extent to which participants were experiencing action crises in personal goals (for left NAcc-left FPC connectivity: $\beta = .43$, $p = .025$; for right NAcc-left FPC connectivity: $\beta = .44$, $p = .018$; see Table 1).

Table 1

Hierarchical Multiple Regression Analyses Predicting Left NAcc-Left FPC Connectivity and Right NAcc-left FPC Connectivity From Action Crises Regarding Personal Goals (Study 2)

	Left NAcc-left FPC connectivity		Right NAcc-left FPC connectivity	
Predictor	ΔR^2	β	ΔR^2	β
Step 1	.12		.14	
Control variables[a]				
Step 2	.14*		.15*	
Action crisis		.43*		.44*
Total R^2	.27*		.29*	
n	33		33	

Note. NAcc = nucleus accumbens; FPC = anteroventral prefrontal/lateral frontopolar cortex. For action crisis, values are averaged over the three personal goals.

[a]Control variables included action orientation and neuroticism.

*$p < .05$.

The exploratory whole-brain approach confirmed the association of FPC-NAcc rsFC with action crises. Additional regions outside of our primary hypothesis are shown and discussed in the Supplementary material (Section G).

Action orientation, action crisis, and functional connectivity. In order to test hypothesis 4, i.e., whether action crises in personal goals mediated the relationship between action orientation and fronto-accumbal decoupling (see Supplementary material, Supplementary Table 2, Section F), we performed two mediation analyses (Baron & Kenny, 1986), for left NAcc-left FPC connectivity (see Figure 3) and for right NAcc-left FPC connectivity (see Figure 4).

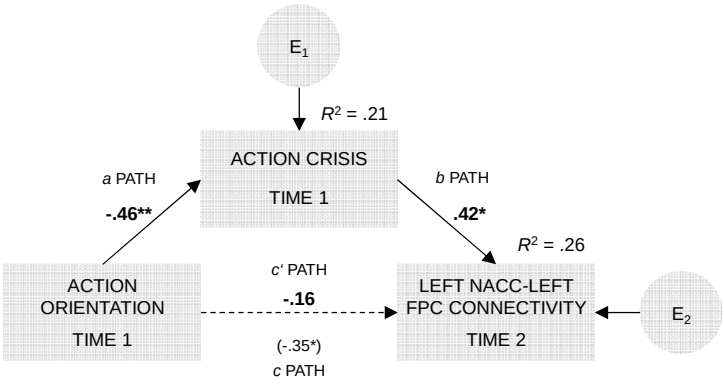


Figure 3. A mediation model of action orientation, action crisis (averaged over all goals), and left NAcc-left FPC connectivity. Action crisis was a significant mediating factor between action orientation and left NAcc-left FPC connectivity. *Note*. NAcc = nucleus accumbens; FPC = frontopolar cortex. R^2 indicates the total explained variance (i.e., the total effect on left NAcc-left FPC connectivity). Dotted regression paths are not significant. Bold regression paths are statistically significant (*p < .05, **p < .01).

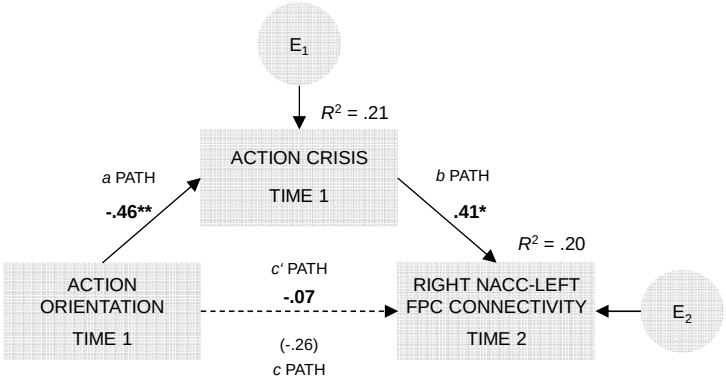


Figure 4. A mediation model of action orientation, action crisis (averaged over all goals), and right NAcc-left FPC connectivity. Action crisis was a significant mediating factor between action orientation and right NAcc-left FPC connectivity. *Note*. NAcc = nucleus accumbens; FPC = frontopolar cortex. R^2 indicates the total explained variance (i.e., the total effect on right NAcc-left FPC connectivity). Dotted regression paths are not significant. Bold regression paths are statistically significant (*p < .05, **p < .01).

By explaining 55 (left NAcc-left FPC connectivity) or rather 72 percent (right NAcc-left FPC connectivity), respectively, of the relationship between action orientation and fronto-accumbal decoupling, action crises in personal goals significantly mediated the relationship between predictor and outcome variable (for statistical details, see Tables 2 and 3).

Table 2

Mediation Analysis of Action Crisis Partly Accounting for the Association Between Action Orientation and Left NAcc-Left FPC connectivity (Study 2)

Effect	*Standardized Estimate*	*C.R.*	*SE*	*95% CI*	*p*
c path (total effect)	-.35	-2.13			= .034
a path	-.46	-2.90			= .004
b path	.42	2.47			= .014
a x *b* (indirect effect)	-.19		.10	(-.450, -.033)	= .016
c ' path (direct effect)	-.16	-.94			= .347

Note. CI = confidence interval. C.R. = critical ratio. Maximum likelihood estimates are provided for the c path, a path, b path, and c' path. For the standardized indirect effect (a x b), bootstrap estimates with confidence intervals are provided.

Table 3

Mediation Analysis of Action Crisis Partly Accounting for the Association Between Action Orientation and Right NAcc-Left FPC connectivity (Study 2)

Effect	*Standardized Estimate*	*C.R.*	*SE*	*95% CI*	*p*
c path (total effect)	-.26	-1.51			= .132
a path	-.46	-2.90			= .004
b path	.41	2.31			= .021
a x *b* (indirect effect)	-.19		.11	(-.452, -.025)	= .022
c ' path (direct effect)	-.07	-.40			= .691

Note. CI = confidence interval. C.R. = critical ratio. Maximum likelihood estimates are provided for the c path, a path, b path, and c' path. For the standardized indirect effect (a x b), bootstrap estimates with confidence intervals are provided.

General Discussion

The concept of an action crisis is defined as the intra-psychic conflict between further goal pursuit and disengagement from the goal and represents a methodologically new approach that provides critical insight into goal disengagement processes. Even though not every action crisis leads into goal disengagement, the ACRISS (Brandstätter & Schüler, 2013) allows for analyzing situational and dispositional circumstances under which the focal goal, *in* the course of goal pursuit, becomes questioned and, ultimately, relinquished. In the present research, we applied the ACRISS to study the cognitive (Study 1) and neural (Study 2) basis of questioning a goal (i.e., experiencing an action crisis) in the midst of goal pursuit.

In line with our theorizing, in Study 1, an action crisis gave rise to an increased and unbiased re-evaluation of goal-related costs and benefits (i.e., rewards) and thereby reduced goal shielding (Shah et al., 2002). Whereas an unbiased goal re-evaluation, i.e., an objective

and impartial perspective, may support an adequate resolution of the conflict, it is likely to interfere with the pursuit of the goal.

In Study 2, we aimed at identifying a neural activity pattern that forms the basis of increased goal-related cost-benefit thinking in action crises (cf. Study 1). As, in an action crisis, impairments in behavioral goal pursuit are most likely attributable to increased reward-related impact on prefrontal action control (cf. goal shielding, Study 1; see also Brandstätter & Schüler, 2013), we assessed connectivity between NAcc and FPC in individuals varying in the extent of experienced action crises in personal long-term goals. In line with our hypotheses, we found that FPC-NAcc rsFC was positively correlated with the degree of experienced action crises. Conversely, FPC-NAcc rsFC was negatively associated with action orientation. Furthermore, action crises mediated the relationship between action orientation and FPC-NAcc rsFC.

The results of Study 2 are consistent with research demonstrating the importance of FPC-NAcc connectivity for (task) goal-related "desire-reason dilemma[s]" (Diekhof & Gruber, 2010, p. 1489) and its association with trait impulsivity (Diekhof & Gruber, 2010; Diekhof et al., 2012). Importantly, the left FPC, along with its functional connectivity to the NAcc, has been shown to play a key role in attention-deficit/hyperactivity disorder, which is characterized by deficient action control (i.e., impulsive behavior) (Dias et al., 2013). Whereas the NAcc is well-known for representing an interface between motivation and action, the functions of the FPC (as opposed to other prefrontal areas) have become subject to empirical research in recent time. Lesion studies, for example, point to a role of FPC in decision-making (Gläscher et al., 2012; Kovach et al., 2012). In an action crisis, an individual is captured in the decision between further goal pursuit and disengagement from the goal (Brandstätter et al., in press). Furthermore, perfectly in line with the concept of an action crisis and the present results, FPC activity is implicated in the process of exploring alternative

goals while keeping the main goal in mind (Daw, O'Doherty, Dayan, Seymour, & Dolan, 2006; Koechlin, Basso, Pietrini, Panzer, & Grafman, 1999), weighing the advantages of not chosen alternatives (Boorman, Behrens, & Rushworth, 2011), and behavioral switching (Boorman, Behrens, & Rushworth, 2011; Boorman, Behrens, Woolrich, & Rushworth, 2009).

The relationship between FPC-NAcc functional connectivity and action crises may be interpreted in two ways. First, increased direct "proactive" correspondence between FPC and NAcc in action crises may underlie the observed results. The synchronization of cortical and subcortical subsystems might involve active recruitment (top-down) of (additional) goal-related motivational resources instantiated in the NAcc or, vice versa, the relay of motivational inputs to the FPC (bottom-up) for updating implemented task-sets (Sakai & Passingham, 2006). This interpretation is in accordance with Koechlin and Hyafil (2007, p. 594) who construed the FPC as a system for "protecting the execution of long-term mental plans [...] and for generating new, possibly more rewarding, behavioral or cognitive sequences". These scenarios would be perfectly in line with the concept of an action crisis as an *adaptive* phase in goal striving (Brandstätter et al., in press).

Second, our results could be interpreted in the background of studies indicating that a *decrease* of reward-related activation in the NAcc is associated with a relative *increase* of FPC activation, i.e., negative functional connectivity between these areas. Specifically, this has been shown in an experimental setting in which the pursuit of a long-term *task* goal required participants to abstain from immediate rewards (Diekhof & Gruber, 2010; Diekhof et al., 2012) and under pharmacological treatment with antidepressive drugs (Abler, Grön, Hartmann, Metzger, & Walter, 2012). Accordingly, subjects in action crises may exhibit *reduced* top-down inhibition of the NAcc. An impaired *de*segregation of neural subsystems centered in the left FPC and NAcc, furthermore, could provide an explanation of the negative consequences of action crises on goal pursuit (Brandstätter et al., in press). In support of this

line of thought, behavioral stability, on the neural level, has been shown to be reflected by the magnitude of the segregation of resting-state networks (Kelly, Uddin, Biswal, Castellanos, & Milham, 2008).

It seems most probable that functional connectivity in the brain is attributable to a combination of more transient ("state") and more long-lasting ("trait") aspects. In fact, neuroscientific research indicates that rsFC may be ascribed to both, dynamic states (Schultz, Balderston, & Helmstetter, 2012) as well as more stable personality traits (Adelstein et al., 2011). Correspondingly, in Study 2, FPC-NAcc rsFC was associated with action orientation (trait) *and* action crises (state) (cf. Supplementary material, Supplementary Table 2). However, as the relationship between action crises and FPC-NAcc rsFC was not merely more profound than between action orientation and FPC-NAcc rsFC but remained when controlling for action orientation and, furthermore, action crises mediated the relationship between action orientation and FPC-NAcc rsFC, the conclusion seems warranted that the (more proximal and constitutive) effect of action crises on fronto-accumbal dynamics exists independent of the (more distal) influence of trait action orientation.

Resting-state fMRI results of Study 2 underscore the significance of connectivity between FPC and NAcc for (long-term) goal-related processing, especially in the face of increased impact of goal-relevant rewards on action control (i.e., in an action crisis). Study 2, thereby, extends and complements previous approaches that applied task-based fMRI to examine similar goal-related neural processes in the context of long-term *task* goals (Diekhof & Gruber, 2010; Diekhof et al., 2012).

Resting-state fMRI enables to map how an individual's subjective constitution is linked to *intrinsic* neural processes (Kelly et al., 2012). Following this idea, and in order to reduce "acute" and unspecific effects (e.g., biases through action crisis-related affect and stress), participants, while in the scanner, were neither prompted to actively think about their

long-term goals nor instructed to perform a goal-related task. Correspondingly, goal-related questionnaires were completed by participants at home and results remained significant when controlling for state anxiety (analyses not shown). The examination of subjects that vary in the extent of experienced action crises in a task-*in*dependent quasi-experimental setting allowed for connecting constitutive aspects of the pursuit of long-term goals with resting-state connectivity. A task-based (i.e., experimental) approach, on the contrary, would have required to dissociate goal-related long-term from task-specific effects (cf. Berkman & Lieberman, 2009). Therefore, our results have specific implications for the neurobiological dynamics underlying the pursuit of long-term goals.

Limitations and future directions

Our results do not allow any inferences about the directional nature (top-down vs. bottom-up) of fronto-accumbal dynamics and the nature of electrophysiological processes (inhibitory vs. excitatory) at neuronal transition zones in the presence of an action crisis. Thus, either of the discussed interpretations (cf. above), or a combination of both, may be true. Due to the focus on ROI-based analyses in the FPC and NAcc, we refrain from statements about larger goal-related functional networks across the whole brain. Given these limitations, future studies may use further methods paralleling fMRI and, for example, explicitly address the issue of neuronal inhibition/excitation of NAcc by the FPC, analyze effective connectivity to estimate causal relationships within prefronto-striatal routes, and examine additional regions interacting with FPC and NAcc in action crises. Third-party regions such as medial prefrontal cortex might have mediated the observed fronto-accumbal functional interactions. Follow-up analyses may evaluate whether fronto-accumbal connectivity, possibly in interaction with action orientation, predicts the outcome and/or the overcoming of an action crisis.

Concluding remarks

We draw attention to altered FPC-NAcc rsFC as a constitutive characteristic and/or adaptive mechanism in response to the experience of an action crisis. To the best of our knowledge, the present research is one of the very first to link motivationally relevant cognitive processes (Study 1) to NAcc-related functional connectivity in the resting state (Study 2). It also represents a new approach to the analysis of the neural underpinnings of the pursuit of long-term goals. The practical relevance of the analysis of neural mechanisms that form the basis of the experience of an action crises appears evident when considering the enormous significance of personal goals for affect, cognition, and behavior (Moskowitz & Grant, 2009).

References

Abler, B., Grön, G., Hartmann, A., Metzger, C., & Walter, M. (2012). Modulation of frontostriatal interaction aligns with reduced primary reward processing under serotonergic drugs. *The Journal of Neuroscience, 32*(4), 1329-1335. doi: 10.1523/jneurosci.5826-11.2012

Achtziger, A., Gollwitzer, P. M., & Sheeran, P. (2008). Implementation intentions and shielding goal striving from unwanted thoughts and feelings. *Personality and Social Psychology Bulletin, 34*(3), 381-393. doi: 10.1177/0146167207311201

Adelstein, J. S., Shehzad, Z., Mennes, M., DeYoung, C. G., Zuo, X.-N., Kelly, C., et al. (2011). Personality is reflected in the brain's intrinsic functional architecture. *PLoS One, 6*(11). doi: 10.1371/journal.pone.0027633

Albert, N. B., Robertson, E. M., Mehta, P., & Miall, R. C. (2009). Resting state networks and memory consolidation. *Communicative & Integrative Biology, 2*(6), 530-532.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trotschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*(6), 1014-1027. doi: http://dx.doi.org/10.1037/0022-3514.81.6.1014

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182. doi: 10.1037/0022-3514.51.6.1173

Baumann, N., Kaschel, R., & Kuhl, J. (2005). Striving for unwanted goals: Stress-dependent discrepancies between explicit and implicit achievement motives reduce subjective well-being and increase psychosomatic symptoms. *Journal of Personality and Social Psychology, 89*(5), 781-799. doi: http://dx.doi.org/10.1037/0022-3514.89.5.781

Baumann, N., Kaschel, R., & Kuhl, J. (2007). Affect sensitivity and affect regulation in dealing with positive and negative affect. *Journal of Research in Personality, 41*(1), 239-248. doi: http://dx.doi.org/10.1016/j.jrp.2006.05.002

Baur, V., Hänggi, J., Langer, N., & Jäncke, L. (2013). Resting-State Functional and Structural Connectivity Within an Insula–Amygdala Route Specifically Index State and Trait Anxiety. *Biological Psychiatry, 73*(1), 85-92. doi: http://dx.doi.org/10.1016/j.biopsych.2012.06.003

Berkman, E. T., & Lieberman, M. D. (2009). The neuroscience of goal pursuit: Bridging gaps between theory and data. In G. B. Moskowitz & H. Grant (Eds.), *The psychology of goals.* (pp. 98-126). New York, NY: Guilford Press.

Boorman, E. D., Behrens, T. E., & Rushworth, M. F. (2011). Counterfactual choice and learning in a neural network centered on human lateral frontopolar cortex. *PLoS Biology, 9*(6). doi: 10.1371/journal.pbio.1001093

Boorman, E. D., Behrens, T. E. J., Woolrich, M. W., & Rushworth, M. F. S. (2009). How green is the grass on the other side? Frontopolar cortex and the evidence in favor of alternative courses of action. *Neuron, 62*(5), 733-743.

Brandstätter, V., Herrmann, M., & Schüler, J. (in press). The struggle of giving up - Affective, physiological, and cognitive consequences of an action crisis. *Personality and Social Psychology Bulletin*.

Brandstätter, V., & Schüler, J. (2013). Action crisis and cost–benefit thinking: A cognitive analysis of a goal-disengagement phase. *Journal of Experimental Social Psychology, 49*, 543-553. doi: 10.1016/j.jesp.2012.10.004

Brandtstädter, J. (2007). *Das flexible Selbst: Selbstentwicklung zwischen Zielbindung und Ablösung [The flexible self: Self-development between goal commitment and disengagement]* (1 ed.). Munich: Elsevier.

Brunstein, J. C. (1989). Action-oriented vs state-oriented reactions to experimentally-induced failure. *Zeitschrift fur Experimentelle und Angewandte Psychologie, 36*(3), 349-367.

Brunstein, J. C. (1993). Personal goals and subjective well-being: A longitudinal study. *Journal of Personality and Social Psychology, 65*(5), 1061-1070. doi: http://dx.doi.org/10.1037/0022-3514.65.5.1061

Brunstein, J. C. (2001). Personal goals and action versus state orientation: Who builds a commitment to realistic and need-congruent goals? *Zeitschrift für Differentielle und Diagnostische Psychologie, 22*(1), 1-12. doi: http://dx.doi.org/10.1024//0170-1789.22.1.1

Carver, C. S., & Scheier, M. F. (2005). Engagement, disengagement, coping, and catastrophe. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation.* (pp. 527-547). New York, NY: Guilford Publications.

Cauda, F., Cavanna, A. E., D'Agata, F., Sacco, K., Duca, S., & Geminiani, G. C. (2011). Functional connectivity and coactivation of the nucleus accumbens: a combined functional connectivity and structure-based meta-analysis. *Journal Of Cognitive Neuroscience, 23*(10), 2864-2877.

Chao-Gan, Y., & Yu-Feng, Z. (2010). DPARSF: A MATLAB Toolbox for "Pipeline" Data Analysis of Resting-State fMRI. *Frontiers In Systems Neuroscience, 4*, 13-13.

Daw, N. D., O'Doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature, 441*(7095), 876-879.

Dias, T. G. C., Wilson, V. B., Bathula, D. R., Iyer, S. P., Mills, K. L., Thurlow, B. L., et al. (2013). Reward circuit connectivity relates to delay discounting in children with attention-deficit/hyperactivity disorder. *European Neuropsychopharmacology, 23*(1), 33-45. doi: 10.1016/j.euroneuro.2012.10.015

Diekhof, E. K., & Gruber, O. (2010). When desire collides with reason Functional interactions between anteroventral prefrontal cortex and nucleus accumbens underlie the human ability to resist impulsive desires. *The Journal of Neuroscience, 30*(4), 1488-1493. doi: http://dx.doi.org/10.1523/JNEUROSCI.4690-09.2010

Diekhof, E. K., Nerenberg, L., Falkai, P., Dechent, P., Baudewig, J., & Gruber, O. (2012). Impulsive personality and the ability to resist immediate reward: An fMRI study examining interindividual differences in the neural mechanisms underlying self-control. *Human Brain Mapping, 33*(12), 2768-2784. doi: 10.1002/hbm.21398

Emmons, R. A. (1986). Personal strivings: An approach to personality and subjective well-being. *Journal of Personality and Social Psychology, 51*(5), 1058-1068. doi: http://dx.doi.org/10.1037/0022-3514.51.5.1058

Emmons, R. A. (1996). Striving and feeling: Personal goals and subjective well-being. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior.* (pp. 313-337). New York, NY: Guilford Press.

Förster, J., & Denzler, M. (2009). A social-cognitive perspective on automatic self-regulation: The relevance of goals in the information-processing sequence. In F. Strack & J. Förster (Eds.), *Social cognition: The basis of human interaction.* (pp. 245-267). New York, NY US: Psychology Press.

Förster, J., Liberman, N., & Friedman, R. S. (2009). What do we prime? On distinguishing between semantic priming, procedural priming, and goal priming. In E. Morsella, J. A. Bargh & P. M. Gollwitzer (Eds.), *Oxford handbook of human action.* (pp. 173-192). New York, NY US: Oxford University Press.

Fox, M. D., & Raichle, M. E. (2007). Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. *Nature Reviews. Neuroscience, 8*(9), 700-711.

Gläscher, J., Adolphs, R., Damasio, H., Bechara, A., Rudrauf, D., Calamia, M., et al. (2012). Lesion mapping of cognitive control and value-based decision making in the prefrontal cortex. *Proceedings Of The National Academy Of Sciences Of The United States Of America, 109*(36), 14681-14686. doi: 10.1073/pnas.1206608109

Gollwitzer, P. M. (2012). Mindset theory of action phases. In P. Lange, A. W. Kruglanski & T. E. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 526-545). Thousand Oaks, CA: Sage Publications Ltd.

Gollwitzer, P. M., Heckhausen, H., & Steller, B. (1990). Deliberative and implemental mind-sets: Cognitive tuning toward congruous thoughts and information. *Journal of Personality and Social Psychology, 59*(6), 1119-1127. doi: http://dx.doi.org/10.1037/0022-3514.59.6.1119

Herrmann, M., & Brandstätter, V. (2013a). *Action orientation promotes health and well-being by preventing action crises in personal goals*. Manuscript submitted for publication.

Herrmann, M., & Brandstätter, V. (2013b). *Cognitive tuning among personal goals - Action crises and goal-independent cognition*. Manuscript submitted for publication.

Kelly, A. M. C., Biswal, B. B., Craddock, R. C., Castellanos, F. X., & Milham, M. P. (2012). Characterizing variation in the functional connectome: promise and pitfalls. *Trends in Cognitive Sciences, 16*(3), 181-188.

Kelly, A. M. C., Uddin, L. Q., Biswal, B. B., Castellanos, F. X., & Milham, M. P. (2008). Competition between functional brain networks mediates behavioral variability. *Neuroimage, 39*(1), 527-537.

Kenny, D. A., & Harackiewicz, J. M. (1979). Cross-lagged panel correlation: Practice and promise. *Journal of Applied Psychology, 64*(4), 372-379. doi: 10.1037/0021-9010.64.4.372

Klinger, E. (1977). *Meaning & void: Inner experience and the incentives in people's lives*. Minneapolis, MN: University of Minnesota Press.

Koechlin, E., Basso, G., Pietrini, P., Panzer, S., & Grafman, J. (1999). The role of the anterior prefrontal cortex in human cognition. *Nature, 399*(6732), 148-151.

Koechlin, E., & Hyafil, A. (2007). Anterior prefrontal function and the limits of human decision-making. *Science (New York, N.Y.), 318*(5850), 594-598.

Koole, S. L. (2004). Volitional shielding of the self: Effects of action orientation and external demands on implicit self-evaluation. *Social Cognition, 22*(1), 100-125. doi: 10.1521/soco.22.1.100.30985

Kovach, C. K., Daw, N. D., Rudrauf, D., Tranel, D., O'Doherty, J. P., & Adolphs, R. (2012). Anterior prefrontal cortex contributes to action selection through tracking of recent reward trends. *The Journal Of Neuroscience: The Official Journal Of The Society For Neuroscience, 32*(25), 8434-8442.

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 331-378). San Diego, CA: Academic Press.

Kuhl, J. (1981). Motivational and functional helplessness: The moderating effect of state versus action orientation. *Journal of Personality and Social Psychology, 40*(1), 155-170. doi: http://dx.doi.org/10.1037/0022-3514.40.1.155

Kuhl, J. (1992). A theory of self-regulation: Action versus state orientation, self-discrimination, and some applications. *Applied Psychology: An International Review, 41*(2), 97-129. doi: http://dx.doi.org/10.1111/j.1464-0597.1992.tb00688.x

Kuhl, J. (1994a). Action versus state orientation: Psychometric properties of the Action Control Scale (ACS-90). In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action versus state orientation* (pp. 47-59). Göttingen, Germany: Hogrefe.

Kuhl, J. (1994b). A theory of action and state orientation. In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action versus state orientation* (pp. 9-46). Göttingen, Germany: Hogrefe.

Kuhl, J., & Koole, S. L. (2004). Workings of the will: A functional approach. In J. Greenberg, S. L. Koole & T. Pyszczynski (Eds.), *Handbook of Experimental Existential Psychology.* (pp. 411-430). New York, NY: Guilford Press.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review Of Neuroscience, 24*, 167-202.

Mogenson, G. J., Jones, D. L., & Yim, C. Y. (1980). From motivation to action: functional interface between the limbic system and the motor system. *Progress in Neurobiology, 14*(2-3), 69-97.

Moskowitz, G. B., & Grant, H. (2009). *The psychology of goals*. New York, NY: Guilford Press.

Nenkov, G. Y., & Gollwitzer, P. M. (2012). Pre- versus postdecisional deliberation and goal commitment: The positive effects of defensiveness. *Journal of Experimental Social Psychology, 48*(1), 106-121. doi: 10.1016/j.jesp.2011.08.002

Sakai, K., & Passingham, R. E. (2006). Prefrontal set activity predicts rule-specific neural processing during subsequent cognitive performance. *The Journal Of Neuroscience: The Official Journal Of The Society For Neuroscience, 26*(4), 1211-1218.

Schnelle, J., Brandstätter, V., & Knöpfel, A. (2010). The adoption of approach versus avoidance goals: The role of goal-relevant resources. *Motivation and Emotion, 34*(3), 215-229. doi: http://dx.doi.org/10.1007/s11031-010-9173-x

Schultz, D. H., Balderston, N. L., & Helmstetter, F. J. (2012). Resting-state connectivity of the amygdala is altered following Pavlovian fear conditioning. *Frontiers in Human Neuroscience, 6*. doi: 10.3389/fnhum.2012.00242

Sesack, S. R., & Grace, A. A. (2010). Cortico-Basal Ganglia reward network: microcircuitry. *Neuropsychopharmacology: Official Publication Of The American College Of Neuropsychopharmacology, 35*(1), 27-47.

Shah, J. Y., Friedman, R., & Kruglanski, A. W. (2002). Forgetting all else: On the antecedents and consequences of goal shielding. *Journal of Personality and Social Psychology, 83*(6), 1261-1280. doi: http://dx.doi.org/10.1037/0022-3514.83.6.1261

Shah, J. Y., & Kruglanski, A. W. (2002). Priming against your will: How accessible alternatives affect goal pursuit. *Journal of Experimental Social Psychology, 38*(4), 368-383. doi: http://dx.doi.org/10.1016/S0022-1031%2802%2900005-7

Smith, E. R., Stewart, T. L., & Buttram, R. T. (1992). Inferring a trait from a behavior has long-term, highly specific effects. *Journal of Personality and Social Psychology, 62*(5), 753-759. doi: 10.1037/0022-3514.62.5.753

Song, X.-W., Dong, Z.-Y., Long, X.-Y., Li, S.-F., Zuo, X.-N., Zhu, C.-Z., et al. (2011). REST: a toolkit for resting-state functional magnetic resonance imaging data processing. *PLoS One, 6*(9), e25031-e25031.

Tanji, J., Shima, K., & Mushiake, H. (2007). Concept-based behavioral planning and the lateral prefrontal cortex. *Trends in Cognitive Sciences, 11*(12), 528-534. doi: http://dx.doiS1364-6613(07)00253-7

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review, 117*(2), 440-463. doi: http://dx.doi.org/10.1037/a0018963

Wang, D.-Y., Liu, D.-Q., Li, S.-F., & Zang, Y.-F. (2012). Increased local synchronization of resting-state fMRI signal after episodic memory encoding reflects off-line memory consolidation. *Neuroreport, 23*(15), 873-878. doi: 10.1097/WNR.0b013e3283587c96

Wrosch, C., Scheier, M. F., Miller, G. E., Schulz, R., & Carver, C. S. (2003). Adaptive self-regulation of unattainable goals: Goal disengagement, goal reengagement, and

subjective well-being. *Personality and Social Psychology Bulletin, 29*(12), 1494-1508. doi: http://dx.doi.org/10.1177/0146167203256921

Being in Two Minds – The Neural Basis of Experiencing Action Crises in Personal Long-Term Goals

Marcel Herrmann, Volker Baur*, Veronika Brandstätter, Jürgen Hänggi, and Lutz Jäncke*

*contributed equally to this work

Supplementary Methods Study 1

SECTION A

Participants and procedure. At T1, a sample of 333 (263 women) psychology students of a first-semester course at the University of Zurich filled out a questionnaire. A 15% attrition rate at time 2 (T2), at the end of the semester (14 weeks later), resulted in a total of 283 students. As the two subgroups did not differ with respect to any study variables, analyses were performed with students who participated in the study at both measurement points.

Action crisis. The extent to which participants were experiencing action crises in the four defined personal goals was assessed with the Action Crisis Scale (ACRISS; Brandstätter & Schüler, 2013). The ACRISS consists of six items measuring different aspects of goal striving being constitutive of a postdecisional goal conflict (i.e., conflict ["I doubt whether I should continue striving for my goal or disengage from it."], setbacks ["Striving for this goal goes without any problems.", reversely coded], implemental disorientation ["When striving for this goal I repeatedly am confronted with situations where I do not know how to continue."], rumination ["I repeatedly ruminate about my goal."], disengagement impulses ["I have thought of disengaging from my goal."], and procrastination ["I repeatedly haven't done anything for my goal despite the intention to do so."]. Each statement was rated on a scale ranging from 1 (no agreement) to 5 (very much agreement). At both time points, the

reliability of the ACRISS, which was assessed for all personal goals separately, was high ($\alpha \geq$ .73 at T1; $\alpha \geq .73$ at T2).

Cost-benefit thinking. Regarding their four personal goals separately (at T1 and T2), participants were advised to indicate the frequency, on a scale ranging from 1 (never) to 5 (very frequently), with which they had recently thought about the costs (CC) and benefits of continuing (BC) the goal as well as the costs (CD) and benefits of disengaging (BD) from the goal, respectively (cf. Brandstätter & Schüler, 2013, Studies 1 and 4). By averaging the benefits of continuing the goal (BC) and the costs of disengaging from the goal (CD), we compiled an index of the deliberation intensity of the pros of the goal (i.e., deliberation in favor of further goal pursuit) ($r \geq .33$ and $r \leq .69$ at T1, all p's < .001; $r \geq .41$ and $r \leq .67$ at T2, all p's < .001). Analogously, the costs of continuing the goal (CC) and the benefits of disengaging from the goal (BD) were used as an index of the deliberation intensity of the cons of the goal (i.e., deliberation in favor of goal disengagement) ($r \geq .18$ and $r \leq .39$ at T1, all p's < .002; $r \geq .42$ and $r \leq .57$ at T2, all p's < .001).

Supplementary Results Study 1

SECTION B

Supplementary Table 1

Means (SDs) and Zero-Order Correlations Among the Major Study Variables

Variable	*M (SD)*	1	2	3	4	5
1. Action crisis (T1)	2.29 (0.51)	–				
2. Action crisis (T2)	2.28 (0.54)	.73***	–			
3. Deliberation goal pursuit (T1)	3.42 (0.68)	.33***	.30***	–		
4. Deliberation goal pursuit (T2)	3.25 (0.87)	.30***	.32***	.62***	–	
5. Deliberation goal disengagement (T1)	1.94 (0.61)	.55***	.43***	.19***	.12*	–
6. Deliberation goal disengagement (T2)	1.75 (0.61)	.46***	.63***	.20***	.23***	.53***

Note. T in T1-T2 = time. For action crisis, deliberation goal pursuit, and deliberation goal disengagement, values are averaged over all four personal goals. Deliberation goal pursuit = deliberation of the pros of the goal; deliberation goal disengagement = deliberation of the cons of the goal.

*$p < .05$. ***$p < .001$.

As can be seen from Supplementary Table 1, in the total sample, on average, the pros of a goal (T1: $M = 3.42$, $SE = 0.04$; T2: $M = 3.25$, $SE = 0.51$) were more frequently deliberated than the cons of a goal (T1: $M = 1.94$, $SE = 0.04$; T2: $M = 1.75$, $SE = 0.04$) at T1 ($t(282) = 30.27$, $p < .001$, $r = .87$) as well as at T2 ($t(282) = 26.98$, $p < .001$, $r = .85$). This was to be expected because the pursuit of a goal is generally associated with the volitional mindset that prevents an individual from processing information implying goal disengagement (Gollwitzer, 2012). In the present research (hypothesis 2), we analyzed if this volitional bias in cost-benefit thinking is reduced by an action crisis. Cross-sectionally, hypothesis 2 is supported by our data as an action crisis, at T1 and T2, was found to be more strongly associated with the deliberation of the cons of a goal (see Supplementary Table 1).

SECTION C

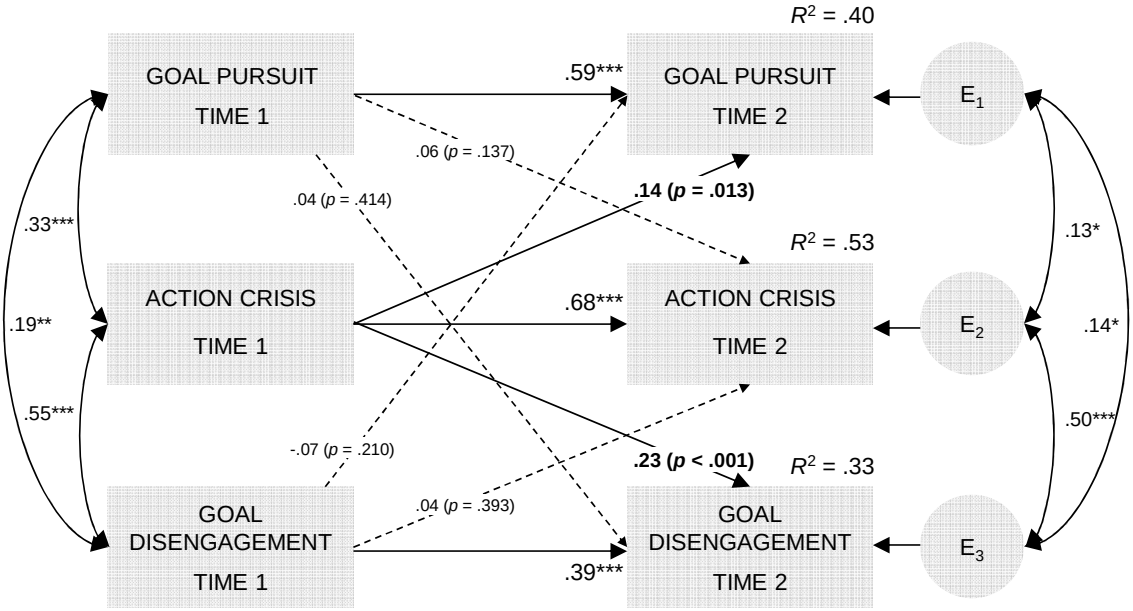
Cross-lagged panel analyses. Whereas, in cross-lagged path models (cf. Figure 1), autoregressive effects (e.g., regression path from action crises T1 to action crises T2) are

indicative of the temporal stability of a variable and act as statistical controls, cross-lagged effects (e.g., regression path from action crises at T1 to goal disengagement at T2) specify the causal relationship between two variables. Therefore, these cross-lagged effects, by allowing for testing our hypotheses, were of theoretical interest in our study (Oud & Delsing, 2010).

As values were averaged across possibly completely different goals for action crises and cost-benefit thinking and therefore no homogeneity (i.e., internal consistency) can be assumed, the analyses included no measurement models.

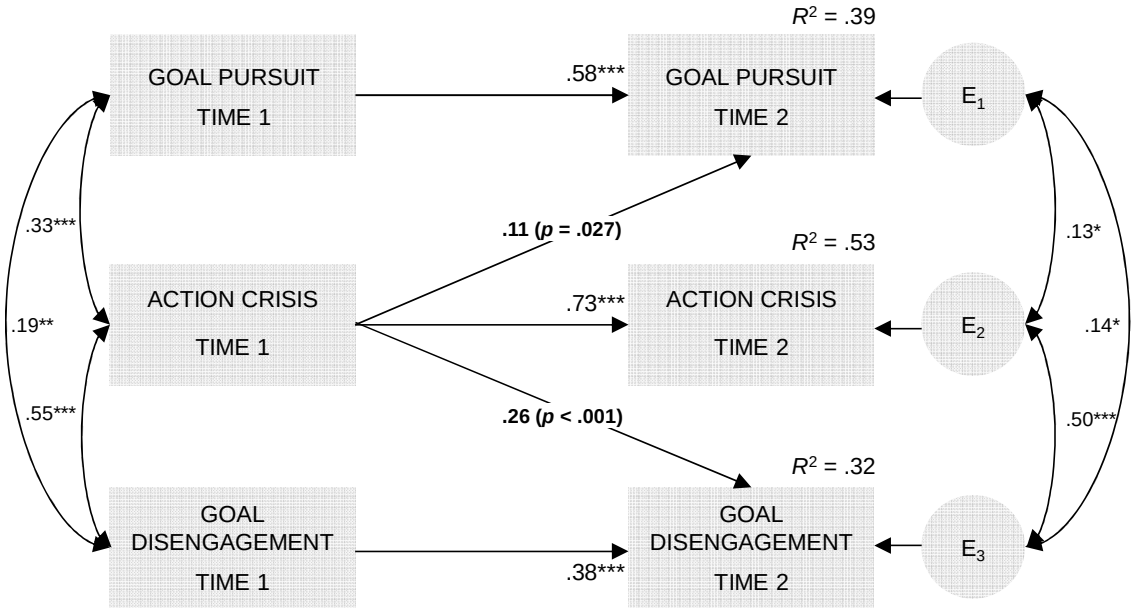
Cross-lagged path analyses were performed using the IBM® SPSS® Amos software (version 20; IBM® SPSS® Statistics Inc., Armonk, NY) based on the variance-covariance matrix. Model fit was estimated by the maximum-likelihood method.

Statistical procedure: Firstly, we examined the full cross-lagged path model (see Supplementary Figure 1). (For reasons of clarity, in the following, the deliberation intensity of the pros of the goal, i.e. deliberation in favor or further goal pursuit, is abbreviated as *goal pursuit* whereas the deliberation intensity of the cons of a goal is abbreviated as *goal disengagement*.) The full model, completely in line with hypothesis 1, showed statistically significant cross-lagged effects of action crises at T1 on goal pursuit (β = .14, t = 2.49, p = .013) and goal disengagement (β = .23, t = 3.86, p < .001) at T2. Conversely, goal disengagement (β = .04, t = 0.86, p = .393) and goal pursuit (β = .06, t = 1.49, p = .137) at T1 neither significantly affected action crises at T2 nor goal disengagement (β = .04, t = 0.82, p = .414) or goal pursuit (β = -.07, t = -1.25, p = .210) at T2, respectively (cross-lagged effects).



Supplementary Figure 1. Full cross-lagged path model for the prediction of cost-benefit thinking at T2 from action crisis (averaged over all goals) at T1 and the prediction of action crisis at T2 from cost-benefit thinking at T1. Note: GOAL PURSUIT = deliberation intensity of the pros of the goal, i.e. in favor of further goal pursuit; GOAL DISENGAGEMENT = deliberation intensity of the cons of the goal, i.e. in favor of goal disengagement. Squares indicate observed variables. A circle indicates a residual error in the prediction of an observed variable. Single-headed arrows represent regression paths. Double-headed arrows represent synchronous correlations. Above endogenous observed variables, R^2 indicates the total amount of explained variance. Broken regression paths did not reached significance in the full cross-lagged path model and were excluded in the final model. Correlation coefficients are statistically significant at $^*p < .05$, $^{**}p < .01$, and $^{***}p < .001$. For regression paths, exact probabilities are reported. Standardized maximum-likelihood parameters are used.

Secondly, having confirmed hypothesis 1 in the full cross-lagged path model (that has zero degrees of freedom and, therefore, does not allow for the estimation of fit indices), we removed the non-significant regression paths from the saturated model to test the model fit of the more parsimonious and theoretically derived model (*Model 1*). The resultant Model 1 (see Supplementary Figure 2), which assumed a causal effect of action crises at T1 on cost-benefit thinking at T2, had excellent indices of fit [$X^2(4) = 4.870$, $p = .301$, $X^2/df = 1.217$, *NNFI* = .995, *CFI* = .999, *RMSEA* = .028 (C.I. .000-.098; PCLOSE = .609)] and could be accepted (Byrne, 2010). Action crises at T1 significantly predicted goal pursuit ($\beta = .26$, $t = 4.60$, $p < .001$) and goal disengagement ($\beta = .11$, $t = 2.21$, $p = .027$) at T2. Hypothesis 1 could therefore be confirmed. An action crisis causally preceded cost-benefit thinking.



Supplementary Figure 2. Cross-lagged path model for the prediction of cost-benefit thinking at T2 from action crisis (averaged over all goals) at T1. Note: For adequate interpretation of the cross-lagged path models, see Figure 1.

Thirdly, in order to test hypothesis 2, we set the regression paths from action crises at T1 to goal pursuit and goal disengagement at T2 in Model 1 to equality. Hence, the resultant more parsimonious Model 2, in accordance with hypothesis 2, specified the effects of an action crisis on the deliberation of the pros *and* cons of a goal as being equally strong. Model 2 had excellent indices of fit [$X^2(5) = 6.460$, $p = .264$, $X^2/df = 1.292$, $NNFI = .994$, $CFI = .998$, $RMSEA = .032$ (C.I. .000-.093; $PCLOSE = .606$)] (Byrne, 2010) . As in Model 1, action crises at T1 significantly predicted cost-benefit thinking at T2 (unstandardized values: $\beta = .26$, SE = .06, $t = 4.73$, $p < .001$; standardized values for goal pursuit, $\beta = .22$, $p < .001$, and goal disengagement, $\beta = .15$, $p < .001$). By statistically comparing Model 2 against Model 1, we obtained evidence that indicates whether the pros and cons of a goal, in consequence of an action crisis, are deliberated objectively. We compared the two nested models by computing the X^2 probability of their deviances (1.59, $df = 1$) using the *pchisq* function of the freely-available statistical software *R* (http://cran.r-project.org). Because the two models did not differ significantly ($p = .207$), in which case the more parsimonious

Model 2 is to be preferred, hypothesis 2 was supported by the model comparison. Therefore, the conclusion may be drawn that an action crisis does not merely give rise to an increased (re)consideration of a goal (hypothesis 1) but that this cost-benefit thinking is *not* biased in favor of the focal goal (hypothesis 2). An action crisis, thus, gives rise to a mindset shift that neutralizes the shielding effect of the volitional mindset.

Supplementary Methods Study 2

SECTION D

Participants and procedures. For magnetic resonance imaging (MRI), we enrolled 35 healthy participants via announcements at bulletin boards on the campus of the University of Zurich and the Federal Institute of Technology Zurich ETH, Switzerland. Exclusion criteria for MRI were general contraindications, substance or drug use, excessive consummation of alcohol and nicotine, a history of medication affecting the central nervous system, a history of neurologic or psychiatric disorders, pregnancy, and age over 40 years. According to self-report and the Annett questionnaire (Annett, 1970), only one subject was left-handed. Written informed consent was obtained from all participants. Subjects were financially compensated for their participation. The study was approved by the local ethics committee and conforms to the Declaration of Helsinki (World Medical Association, 2000). Of the original 35 participants, two were excluded from further analyses. One participant reported a history of antidepressant medication and one participant scored exceptionally high in the lie subscale of the Eysenck Personality Questionnaire (lie score: 8, theoretical maximum: 9; Eysenck & Eysenck, 1964) and, additionally, did not score at all in the ACRISS (Brandstätter, Herrmann, & Schüler, in press), i.e., obtained a score of one that was more than three standard deviations (SD_{ACRISS} = .49) below the mean (M_{ACRISS} = 2.53). The final sample consisted of 33 subjects (18 women, M_{age} = 24.9 years, SD_{age} = 4.57 years, age range: 20-37

years). The majority of participants were undergraduate students (79 percent; 9 men, 17 women), others were graduate students (9 percent; 2 men, 1 woman) or employees (12 percent; 4 men, 0 women).

Action crisis. The reliability of the ACRISS (Brandstätter et al., in press; Brandstätter & Schüler, 2013), for all three goals, was high ($.71 \leq \alpha \leq .89$).

Action orientation. Action orientation was assessed using the Action Control Scale (ACS-90; Kuhl, 1994) that consists of 24 items (e.g., "When I must finish something soon: (a) I find it easy to get it done. (b) I have to push myself to get started."). Internal consistency was satisfactory ($\alpha = .72$). In the present research, the two subscales of the ACS (decision-related [AOD] and failure-related [AOF] action orientation) were of no particular interest. It was hypothesized that the ability to self-generate positive affect (i.e., self-motivation, AOD) and the ability to reduce negative affect (i.e., self-relaxation, AOF) hold – depending on the personality (Baumann, Kaschel, & Kuhl, 2007), the goal, and situational conditions – the same potential for the prevention and the resolution of action crises in personal goals.

Control variables. In the present research, neuroticism (i.e., an individual's sensitivity to negative affect; Baumann et al., 2007) served as a control variable to provide neural evidence of the functional difference between affect regulation (i.e., action orientation) and affect sensitivity (i.e., neuroticism) (cf. Baumann, Kaschel, & Kuhl, 2005; Baumann et al., 2007; Baumann & Kuhl, 2002) and, therefore, to confirm the differential validity of the ACS-90 (Kuhl, 1994). Neuroticism was highly correlated to action orientation ($r = -.67$, $p = .001$) but not to action crises (averaged over all personal goals; $r = .25$, $p = .162$). For assessment of neuroticism, subjects completed the 24 dichotomous items (yes/no format) of the neuroticism subscale of the Eysenck Personality Inventory (Form A) (Eggert, 1983). The neuroticism subscale had good internal consistency ($\alpha = .83$).

Regarding the relationship between rsFC and action crises, neuroticism and action orientation were considered as control variables to preclude the possibility that the relationship between an action crises and fronto-accumbal connectivity may be ascribed to a personality disposition (relevant to goal-related self-regulation, negative affect, or insecurity).

SECTION E

Magnetic resonance imaging. Brain scans were acquired on a 3-T Philips Ingenia whole-body scanner (Philips Medical Systems®, Best, The Netherlands) equipped with a transmit-receive body coil and a commercial 15-element sensitivity encoding head coil array. For each participant, one resting-state functional MRI and one diffusion-weighted sequence were obtained applying spin-echo echo-planar imaging. For resting-state functional MRI, subjects were instructed to keep their eyes closed and encouraged to let their mind wander, thinking of nothing in particular.

Images of resting-state functional MRI were acquired with a spatial resolution of 3 x 3 x 3 mm^3 (reconstructed 1.72 x 1.72 x 3 mm^3). Further imaging parameters were: repetition time, 2.2 s; echo time, 16 ms; field of view, 220 x 220 mm^2; number of slices, 45; sensitivity encoding (SENSE) factor, 1.8. The resting-state functional MRI sequence lasted about 10 min (corresponding to 260 brain volumes). Diffusion was measured along 64 non-collinear directions (b = 1000 s/mm^2) preceded by a non-diffusion-weighted volume (reference volume, b = 0 s/mm^2). Spatial resolution was 2 x 2 x 2 mm^3. Further imaging parameters were: repetition time, 18,941.2 ms; echo time, 63.1 ms; field of view, 224 x 224 mm^2; number of slices, 75; flip-angle, 90º; SENSE factor, 2.0. Acquisition of diffusion-weighted images lasted about 23 min.

Functional imaging data preprocessing. Preprocessing included 1) slice timing correction, 2) realignment accounting for head movement during MRI, 3) linear and non-

linear normalization onto a standard echo-planar imaging template, 4) voxel re-sampling to 2 x 2 x 2 mm^3, 5) smoothing with a Gaussian kernel of 6 mm full width at half maximum, 6) detrending, 7) filtering (such that only frequencies with $0.01 < f < 0.08$ Hz passed), and 8) regressing out confounding variance of nine covariates: six parameters from head motion correction (three translation, three rotation parameters) as well as the global mean signal, white matter signal and cerebrospinal fluid signal based on standard masks implemented in SPM 8. For any subject, movement during resting-state functional MRI did not exceed 3 mm into any direction.

Regions of interest definition. ROIs of left and right NAcc were anatomically defined through probability maps of the Harvard-Oxford Atlas (www.cma.mgh.harvard.edu/fsl_atlas.html) distributed with FSL 4.1.9 (Smith et al., 2004). Probability maps were extracted and thresholded at 40 percent, incorporating only those voxels with a probability of greater than 40 percent to be located within the NAcc. ROI of left FPC was defined according to exact topological information from previous evidence (Diekhof & Gruber, 2010). A 4-mm sphere centered at $x = -24$, $y = 56$, $z = 4$ (Montreal Neurological Institute space, coordinates averaged across four activation foci within left FPC as reported in Diekhof and Gruber (2010)) was created using Wake Forest University Pick Atlas 3.0 (Maldjian, Laurienti, Kraft, & Burdette, 2003).

Supplementary Results Study 2

SECTION F

Supplementary Table 2

Means (SDs) and Zero-Order Correlations Among the Major Study Variables

Variable	*M (SD)*	1	2	3	4	5
1. Action crisis	2.57 (0.43)	–				
2. Action orientation (ACS-90)	9.00 (4.12)	-.46**	–			
3. Left NAcc-left FPC functional connectivity	0.07 (0.17)	.49**	-.35*	–		
4. Right Nacc-left FPC functional connectivity	0.10 (0.17)	.44**	-.26	.78***	–	
5. Left Nacc-left FPC structural connectivity	1.54 (0.16)	.12	.06	-.10	.19	–
6. Right Nacc-left FPC structural connectivity	1.78 (0.13)	-.25	-.11	-.12	.02	-.01

Note. For action crisis, values are averaged over all three personal goals. ACS = Action Control Scale; NAcc = nucleus accumbens; FPC = anteroventral prefrontal/lateral frontopolar. Pearson bivariate correlations are presented here.

*$p < .05$. **$p < .01$. ***$p < .001$.

SECTION G

Exploratory whole-brain analysis. On the single-subject level, whole-brain correlation maps were obtained for both seed ROIs separately using REST toolbox 1.6 (Song et al., 2011). These maps, storing voxel-wise correlation strength with the seed ROI, were *r*-to-*z*-transformed to use them for group-level statistics. Random-effects analysis comprised a one-sample *t*-test examining whether each voxel's *z*-value (i.e. the connection strength with the seed ROI) was different from zero, indicating either positive or negative resting-state functional connectivity (rsFC). Resulting statistical maps were thresholded at $p < .001$ with a cluster threshold of $k = 20$ voxels. These maps were used as masks for subsequent group-level regression analysis (entering ACRISS as regressor) to examine only those voxels that are functionally connected with the NAcc.

The whole-brain exploratory approach yielded additional regions whose connectivity with the NAcc was correlated with action crises in personal goals (see Supplementary Figure 3 and Supplementary Table 3). Negative correlation maps were similar for left and right

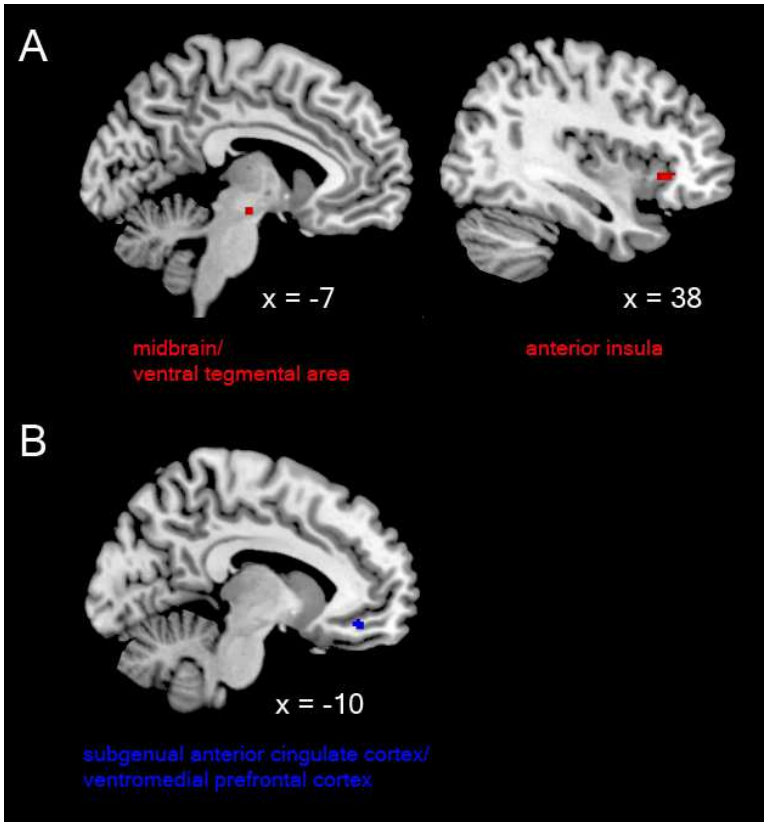
NAcc seed ROIs and included a cluster located in the left subgenual anterior cingulate cortex/ventromedial prefrontal cortex. Positive correlation maps showed right anterior insula (only left NAcc seed), and left ventral tegmental area (only left NAcc seed). Moreover, an identified cluster in the left (but not right) FPC reproduced the results obtained from the ROI-based approach. The resulting maps of the whole-brain analysis showed regions which can all be allocated to a network that is associated with (control of) salience and reward processing. These regions have also been demonstrated to be basically linked to NAcc in the resting state (Cauda et al., 2011). Given the post-hoc like and exploratory character of this analysis as well as the application of a lenient statistical threshold, these results have to be interpreted with care. Findings may be taken into account in future research.

Supplementary Table 3

Regions whose connectivity with the nucleus accumbens is modulated by action crises

		Functional connectivity with left nucleus accumbens seed					**Functional connectivity with right nucleus accumbens seed**				
		cluster		**peak**			**cluster**		**peak**		
		location	size	coordinates	*T*	*p*	location	size	coordinates	*T*	*p*
Correlation with action crises	positive	left FPC	11	-22, 58, 6	3.39	0.001	left FPC	15	-24, 58, 6	3.34	0.001
		right anterior insula	33	36, 26, -4	3.37	0.001					
		left midbrain / VTA	11	-8, -14, -14	2.81	0.004					
	negative	left sgACC / vmPFC	13	-10, 40, -12	3.21	0.002	left sgACC / vmPFC	95	-10, 40, -10	4.76	0.001

Note. Coordinates are reported in Montreal Neurological Institute standard space. Size is depicted in voxels (one voxel = 2 x 2 x 2 mm^3). FPC = frontopolar cortex; VTA = ventral tegmental area; sgACC/vmPFC = subgenual anterior cingulate cortex/ventromedial prefrontal cortex.



Supplementary Figure 3. Statistical maps showing clusters whose functional connectivity with the left nucleus accumbens in the resting state is modulated by action crises, either by a positive (A) or negative (B) correlation ($p < .01$ uncorrected, $k \geq 10$ voxels, $d = 31$, $T \geq 2.45$). The cluster in (B) with a negative correlation was also obtained when using right nucleus accumbens as seed region.

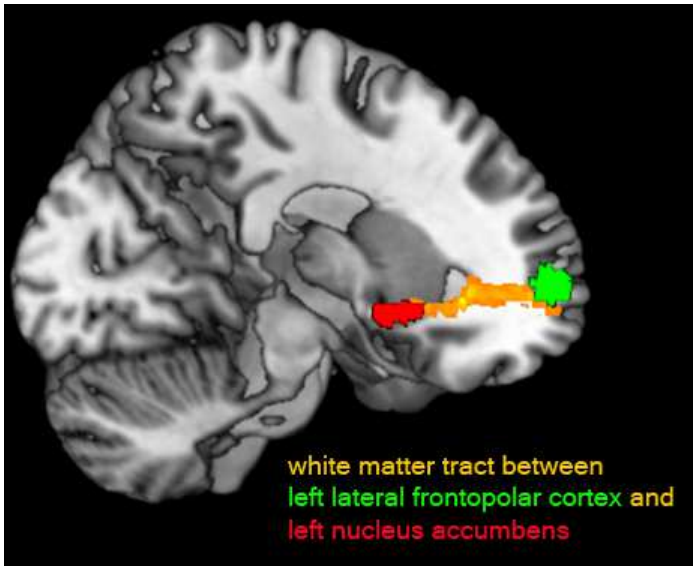
SECTION H

Fronto-accumbal structural connectivity and trait measures of action orientation. In relation to rsFC, *structural* connectivity might be considered more state-*in*dependent. For that reason, we additionally assessed measures of fiber integrity (i.e., structural connectivity) when linking action orientation (i.e., *trait*-related aspects) to fronto-accumbal connectivity. Fiber tracts are the anatomical basis for efficient and dynamic functional interactions between distant brain regions and represent the targets for assessments of structural connectivity. A commonly used measure of structural connectivity is fractional anisotropy, considered as an index of pathway integrity (Mori & Zhang, 2006). Based on the

considerable number of studies that identified action orientation as a predictor of effective goal pursuit (Baumann et al., 2005; Brunstein, 2001; Jostmann & Koole, 2009; Koole, 2004; Kuhl, 1981, 1992; Kuhl & Kazen, 1994), we examined whether action orientation is related to the integrity of tracts connecting left FPC to NAcc.

Diffusion tensor imaging data were preprocessed (removing non-brain tissue (Smith, 2002), head movement correction, gradient redefinition according to movement correction) and subsequently subjected to probabilistic fiber tractography using FMRIB diffusion toolbox 2.0 implemented in FSL 4.1.9 (Smith et al., 2004) (www.fmrib.ox.ac.uk/fsl). Tractography was started in the left and right NAcc (seed ROI), respectively, to find a pathway to left FPC (waypoint and termination mask). When using left NAcc as seed, right NAcc was set as exclusion mask and vice versa. To facilitate tracking, the spherical ROI in the left FPC (already used in the rsFC analysis, see above) was dilated to a diameter of 12 mm for penetration into white matter. Default tracking parameters provided by FMRIB diffusion toolbox were used. Obtained tracts were normalized on the subject-specific level by dividing, voxel-wise, the number of streamlines passing through the voxel by the total number of obtained streamlines for the respective fiber tract (Bartsch, Biller, & Homola, 2009). Subsequently, tracts were thresholded such that only those voxels where at least 5 percent of the total number of streamlines passed were kept. Final tracts were back-transformed from Montreal Neurological Institute space into the native space of subjects and were used as subject-specific masks for extraction of within-tract fractional anisotropy from individual, non-normalized fractional anisotropy maps. In addition, mean fractional anisotropy across the whole brain was obtained for each individual to correct for possible global confounds by building the local-to-global ratio. Finally, tract-based relative mean fractional anisotropy was associated with action orientation (Kuhl, 1994) while statistically controlling for neuroticism (Eggert, 1983).

Due to unsuccessful tractography, one subject had to be excluded from the analysis. Integrity of fibers of an identified pathway between left NAcc and left FPC (see Supplementary Figure 4) was marginally significantly associated with action orientation (r = .30, p = .097). However, there was no significant correlation between action orientation and the tract between right NAcc and left FPC (r = -.01, p = .978). There was no significant correlation with action crisis (p's ≥ .489). Moreover, there were no direct relations between fronto-accumbal functional and structural connectivity (all p's ≥ .295).



Supplementary Figure 4. White matter fiber tract interconnecting frontopolar cortex (green) and nucleus accumbens (red). Trajectory of the fiber bundle is presented as the mean fiber tract across all subjects.

Regarding fronto-accumbal structural connectivity, we obtained slight evidence of a positive association between fiber integrity of an identified pathway connecting left FPC and left NAcc and action orientation. Although, due to the sample size, the effect should be interpreted cautiously, the result provides first evidence of a prefrontally centered neural basis of the volitional ability (of action oriented individuals) to regulate basic affect (Baumann et al., 2007). This may guide future studies in the assessment of how measures of

structural connectivity may predict dispositional action control and parallel the here established evidence of the relationship between rsFC and action crises.

Supplementary References

Annett, M. (1970). A classification of hand preference by association analysis. *British Journal of Psychology, 61*(3), 303-321.

Bartsch, A. J., Biller, A., & Homola, G. A. (2009). Tractography for surgical targets. In H. Johansen-Berg & T. E. J. Behrens (Eds.), *Diffusion MRI: From quantitative measurement to in vivo neuroanatomy*. Amsterdam: Academic Press.

Baumann, N., Kaschel, R., & Kuhl, J. (2005). Striving for Unwanted Goals: Stress-Dependent Discrepancies Between Explicit and Implicit Achievement Motives Reduce Subjective Well-Being and Increase Psychosomatic Symptoms. *Journal of Personality and Social Psychology, 89*(5), 781-799. doi: http://dx.doi.org/10.1037/0022-3514.89.5.781

Baumann, N., Kaschel, R., & Kuhl, J. (2007). Affect sensitivity and affect regulation in dealing with positive and negative affect. *Journal of Research in Personality, 41*(1), 239-248. doi: http://dx.doi.org/10.1016/j.jrp.2006.05.002

Baumann, N., & Kuhl, J. (2002). Intuition, Affect, and Personality: Unconscious Coherence Judgments and Self-Regulation of Negative Affect. *Journal of Personality & Social Psychology, 83*(5), 1213-1223.

Brandstätter, V., Herrmann, M., & Schüler, J. (in press). The struggle of giving up - Affective, physiological, and cognitive consequences of an action crisis. *Personality and Social Psychology Bulletin.*

Brandstätter, V., & Schüler, J. (2013). Action crisis and cost–benefit thinking: A cognitive analysis of a goal-disengagement phase. *Journal of Experimental Social Psychology, 49*, 543-553. doi: 10.1016/j.jesp.2012.10.004

Brunstein, J. C. (2001). Personal goals and action versus state orientation: Who builds a commitment to realistic and need-congruent goals? *Zeitschrift für Differentielle und Diagnostische Psychologie, 22*(1), 1-12. doi: http://dx.doi.org/10.1024//0170-1789.22.1.1

Byrne, B. M. (Ed.). (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge.

Cauda, F., Cavanna, A. E., D'Agata, F., Sacco, K., Duca, S., & Geminiani, G. C. (2011). Functional connectivity and coactivation of the nucleus accumbens: a combined functional connectivity and structure-based meta-analysis. *Journal Of Cognitive Neuroscience, 23*(10), 2864-2877.

Diekhof, E. K., & Gruber, O. (2010). When desire collides with reason Functional interactions between anteroventral prefrontal cortex and nucleus accumbens underlie the human ability to resist impulsive desires. *The Journal of Neuroscience, 30*(4), 1488-1493. doi: http://dx.doi.org/10.1523/JNEUROSCI.4690-09.2010

Eggert, D. (1983). *Eysenck-Persönlichkeits-Inventar E-P-I. Handanweisung für die Durchführung und Auswertung [Manual of the Eysenck Personality Questionnaire]*. Göttingen: Hogrefe.

Eysenck, H. J., & Eysenck, S. B. G. (1964). *Manual of the Eysenck Personality Inventory*. London: University of London Press.

Gollwitzer, P. M. (2012). Mindset theory of action phases. In P. Lange, A. W. Kruglanski & T. E. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 526-545). Thousand Oaks, CA: Sage Publications Ltd.

Jostmann, N. B., & Koole, S. L. (2009). When persistence is futile: A functional analysis of action orientation and goal disengagement *The psychology of goals* (pp. 337-361). New York, NY: Guilford Press; US.

Koole, S. L. (2004). Volitional shielding of the self: Effects of action orientation and external demands on implicit self-evaluation. *Social Cognition, 22*(1), 100-125. doi: 10.1521/soco.22.1.100.30985

Kuhl, J. (1981). Motivational and functional helplessness: The moderating effect of state versus action orientation. *Journal of Personality and Social Psychology, 40*(1), 155-170. doi: http://dx.doi.org/10.1037/0022-3514.40.1.155

Kuhl, J. (1992). A theory of self-regulation: Action versus state orientation, self-discrimination, and some applications. *Applied Psychology: An International Review, 41*(2), 97-129. doi: http://dx.doi.org/10.1111/j.1464-0597.1992.tb00688.x

Kuhl, J. (1994). Action versus state orientation: Psychometric properties of the Action Control Scale (ACS-90). In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action versus state orientation* (pp. 47-59). Göttingen, Germany: Hogrefe.

Kuhl, J., & Kazen, M. (1994). Self-discrimination and memory: State orientation and false self-ascription of assigned activities. *Journal of Personality and Social Psychology, 66*(6), 1103-1115. doi: http://dx.doi.org/10.1037/0022-3514.66.6.1103

Maldjian, J. A., Laurienti, P. J., Kraft, R. A., & Burdette, J. H. (2003). An automated method for neuroanatomic and cytoarchitectonic atlas-based interrogation of fMRI data sets. *Neuroimage, 19*(3), 1233-1239.

Mori, S., & Zhang, J. (2006). Principles of diffusion tensor imaging and its applications to basic neuroscience research. *Neuron, 51*(5), 527-539.

Oud, J. H. L., & Delsing, M. J. M. H. (2010). Continuous time modeling of panel data by means of SEM. In K. van Montfort, J. H. L. Oud & A. Satorra (Eds.), *Longitudinal research with latent variables* (pp. 201-244). New York: Springer.

Smith, S. M. (2002). Fast robust automated brain extraction. *Human Brain Mapping, 17*(3), 143-155.

Smith, S. M., Jenkinson, M., Woolrich, M. W., Beckmann, C. F., Behrens, T. E. J., Johansen-Berg, H., et al. (2004). Advances in functional and structural MR image analysis and implementation as FSL. *Neuroimage, 23 Suppl 1*, S208-S219.

Song, X.-W., Dong, Z.-Y., Long, X.-Y., Li, S.-F., Zuo, X.-N., Zhu, C.-Z., et al. (2011). REST: a toolkit for resting-state functional magnetic resonance imaging data processing. *PLoS One, 6*(9), e25031-e25031.

World Medical Association. (2000). Declaration of Helsinki:Ethical principles for medical research involving human subjects. *The Journal of the American Medical Association, 284*(23), 3043-3045.

Cognitive Tuning Among Personal Goals –

Action Crises and Goal-Independent Cognition

Marcel Herrmann and Veronika Brandstätter

Author Note

Marcel Herrmann and Veronika Brandstätter, Department of Psychology, University of Zurich, Switzerland.

This research was funded by a grant of the Swiss National Science Foundation (SNSF) to Veronika Brandstätter (100014_130131).

Acknowledgments: We would like to thank Tamara Käser and Nico Bächli for their contribution to the coding of thoughts and fairy tales.

Abstract

An *action crisis,* defined as the conflict between further goal pursuit and disengagement, has been shown to be associated with increased goal-related cost-benefit thinking. In the present research, it was evaluated to which extent an action crisis shares the characteristics of a *post*decisional *deliberative mindset* (Gollwitzer, 2012) that is not restricted to the goal but, by *procedural priming,* affects goal-independent cognition. In Study 1, participants (n=190) experiencing an action crisis not merely reported more deliberative goal-related thoughts but, in a goal-independent task, ascribed more deliberative thoughts to a fairy-tale character. Based on the hypothesis that an action crisis in one goal, by the activation of a goal-unspecific deliberative mindset, may transfer to other goals, we conducted Study 2 (n=204). On a correlational basis, an action crisis with respect to a particular goal could be predicted by the extent to which action crises were experienced in other goals. Results advance our understanding of how personal goals influence human cognition and behavior.

Keywords: action crisis, mindset theory of action phases, cognitive tuning, procedural priming, goal disengagement

Introduction

Who has never, during her/his professional career or at the college, once reached a turning point (e.g., after having failed an exam) at which she/he was racking her/his brain over the question whether to keep following the present course of action (e.g., studying law) or choose a different path (e.g., studying art or entering the world of employment)? And who cannot completely empathize with someone who, after goal disengagement has become an option, is captured in such a (goal-related) decisional conflict in which either option is associated with both major benefits and considerable costs? This intra-psychic conflict between further goal pursuit and disengagement from the goal, which typically results from a loss of goal attainability (e.g., due to repeated setbacks) and/or desirability, has been termed as an *action crisis* (Brandstätter, Herrmann, & Schüler, in press; Brandstätter & Schüler, 2013). Even though an action crisis not necessarily leads to goal disengagement (e.g., dropping out of college), it may be assumed that goal disengagement, vice versa, is typically preceded by an action crisis. As goal disengagement, especially if a goal is crucial to an individual's identity (cf. Gollwitzer & Kirchhof, 1998), "can shake one's self-image to its core" (Carver & Scheier, 2005, p. 536), action crises, even if consciously recognized, are difficult to resolve and therefore typically persist over a long period of time (i.e., usually at least several months; cf. Herrmann & Brandstätter, 2013) before a goal is abandoned.

Theoretically, Brandstätter and Schüler (2013) defined the concept of an action crisis within the framework of *mindset theory of action phases* (Gollwitzer, 1990, 2012; H. Heckhausen & Gollwitzer, 1987) that is based on the idea that the pursuit of a goal, in different action phases, is facilitated by the activation of a cognitive orientation (i.e., mindset) that meets the corresponding situational task requirements (Gollwitzer, 2012). In a series of experiments, Brandstätter and Schüler (2013) have provided initial evidence in support of the assumption that the experience of an action crisis, by drawing the attention to the weighing of

goal-related costs and benefits, is associated with a change in the cognitive orientation (*mindset shift*) of the individual.

The pursuit of a goal, in mindset theory (Gollwitzer, 2012), is conceptualized as a sequence of four consecutive action phases: (a) *deliberating* (and choosing between alternative action goals; deliberative phase), (b) *planning* (postdecisional or implemental phase), (c) *acting* (actional phase), and (d) *evaluating* (postactional or evaluative phase). Each phase is associated with specific task demands: In the deliberative (or *motivational*[1]) phase, e.g., the focus lies on goal-setting and thereby on weighing up the pros and cons of different action alternatives, whereas the implemental and actional (i.e., *volitional*) phases involve planning the necessary action steps and acting on the goal, respectively. On the assumption that, in the course of goal pursuit, the phase-typical task demands are met by the activation of corresponding cognitive procedures, Heckhausen and Gollwitzer (Gollwitzer, Heckhausen, & Steller, 1990; H. Heckhausen & Gollwitzer, 1987; for an overview, see Gollwitzer, 2012) have provided abundant evidence for the distinctive characteristics of the *mindsets* (i.e., cognitive functioning) during goal setting (deliberative mindset) and goal striving (implemental and actional mindset), respectively. With respect to thought content, e.g., individuals who are concerned with making a decision between action alternatives were shown to weight up pros (benefits) and cons (costs), whereas individuals who are about to implement a goal focused on the concrete aspects of acting towards the goal (i.e., when, where, and how to implement the goal). In the latter group, costs and benefits were no longer relevant and thus not cognitively represented (H. Heckhausen & Gollwitzer, 1987).

In mindset theory, the deliberative and the two volitional (i.e., implemental and actional) mindsets, owing to functional specificity, are hypothesized to be separated by "clear boundaries" (i.e., forming a goal intention) (Achtziger & Gollwitzer, 2010, p. 276) and therefore "preclude each other" (Gollwitzer & Bayer, 1999, p. 419). Not completely in accord

with this hypothesis, an action crisis, due to the fact that the goal is being re-evaluated *after* having made a goal decision, may be conceptualized as a *post*decisional *deliberative* phase. Even though a goal intention has already been formed and acted on, the individual becomes preoccupied with the dilemma between further goal pursuit and disengagement from the goal. As long as an action crisis persists, an individual typically continues both, to pursue the goal and to constantly weigh the costs and benefits of further goal pursuit against the cost and benefits of disengagement from the goal which, in an action crisis, are temporarily perceived as being balanced (Brandstätter & Schüler, 2013). Consistent with this idea, an action crisis, experimentally as well as longitudinally, could be linked to cognitive (i.e., memory processes) and neural (i.e., resting-state functional connectivity) processes characteristic of the *pre*decisional deliberative mindset (Brandstätter et al., in press; Brandstätter & Schüler, 2013; Herrmann, Baur, Brandstätter, Hänggi, & Jäncke, 2013). As a consequence of increased *post*decisional cost-benefit thinking and, thereby, open-mindedness and impartiality, an action crisis has been found to give rise to a degrading of the goal (with respect to the cognitive evaluation of goal desirability and attainability) that may prepare the ground for disengagement processes (Brandstätter et al., in press; Gollwitzer, 2012).

Whereas the cognitive correlates of an action crisis with respect to goal-dependent cognitive processes have already been analyzed (Brandstätter & Schüler, 2013; Herrmann et al., 2013), so far, no research has focused on the consequences of action crises on *goal-independent* cognition. Compelling evidence for the assumption that an action crisis results in a *mindset shift*, as posited by Brandstätter and Schüler (2013, p. 551), however, would be provided if it could be demonstrated that the cognitive orientation associated with an action crisis is *not* restricted to the focal goal, i.e., not goal-specific. If an action crisis, in fact, elicits a goal-*un*specific deliberative mindset in the real sense of mindset theory (Gollwitzer, 1990, 2012), the associated cognitive orientation should transfer to goal-independent tasks. The

hypothesis of a transfer to goal-independent tasks is supported by research on *procedural priming* (Bargh & Chartrand, 2000; Förster, Liberman, & Friedman, 2009; Smith & Branscombe, 1987; Tulving & Schacter, 1990), especially in the context[2] of mindsets (Gollwitzer et al., 1990). Therefore, in the present article, we attempted to address the question as to what extent the experience of an action crisis in a self-relevant personal goal affects cognitive processes in a goal-independent context.

As the finding of *goal-related* (i.e., goal-specific) cost-benefit thinking (Brandstätter & Schüler, 2013; Herrmann et al., 2013), which provides the rationale for the analysis of a goal-*un*specific mindset in action crises, is based on self-report questionnaires, we performed a pre-study in which a thought-sampling was used (H. Heckhausen & Gollwitzer, 1987). With the aim of reducing potential response bias of previous studies, we analyzed the consequences of action crises on the *spontaneous* goal-related stream of thought and, thereby, attempted to obtain conclusive evidence of a goal-specific mindset in an action crisis.

In the following, we will outline the theoretical basis of our hypotheses and discuss how the present research, by analyzing procedural priming effects in the context of personal goals, may advance our understanding of the psychology of goals.

Procedural priming, drawing on the concept of *transfer appropriate processing* (Morris, Bransford, & Franks, 1977) and *processing shift theory* (Schooler, 2002; Schooler, Fiore, & Brandimonte, 1997), has been defined as the priming of cognitive procedures (e.g., ways of processing information; Förster et al., 2009). Cognitive procedures, once activated (priming phase), remain active for a certain amount of time, even if the task is changed, and thereby may transfer to subsequent (test) tasks, on condition that the subsequent task allows for the adoption of the cognitive procedures activated in the priming phase (Förster et al., 2009). Procedural priming effects have been observed in different contexts (e.g., creativity; Friedman, Fishbach, Förster, & Werth, 2003; self-regulation; Fujita, Trope, & Liberman,

2006; inference formation; Kirmani, Lee, & Yoon, 2004). In contrast to semantic priming (cf. McNamara, 2005) and/or goal priming (cf. Moskowitz & Gesundheit, 2009), procedural priming is free of semantic content, *not* dependent on dynamic motivational processes, i.e., "relatively insensitive to changes in value and expectancy" (Förster et al., 2009, p. 182), and not attributable to learning processes. Whereas procedural priming effects may be conceived of as the consequence of (the adaptation of the cognitive apparatus to) the task requirements of a *previous* situation and, therefore, are of no adaptive value for the *ongoing* task, goal priming represents a prime example of adaptive functional flexibility. Goal priming effects may not merely increase over time and systematically vary with the expectancy and value of a goal, but account for goal shielding, and, furthermore, are counterbalanced if a goal has been achieved (Förster et al., 2009; Kruglanski et al., 2002). However, in contrast to the extensive research on goal priming (cf. Moskowitz & Gesundheit, 2009), the significance of procedural priming for goal-related self-regulation has not been subject to systematic scientific study, even though it is "a legitimate matter of interest whether intentional goal pursuits in one context influence the individual's decisions and behavior in subsequent contexts" (Bargh & Chartrand, 2000, p. 265). In the present article, we illustrate, with the concept of an action crisis, how procedural priming (within goal systems) may become relevant to the pursuit of long-term goals (in everyday life).

The present research was inspired by a pioneer study on procedural priming by Gollwitzer et al. (1990) in which evidence for a "mind-set congruency effect" (p. 1122) was provided. Gollwitzer et al. (1990) demonstrated that mindsets, once activated by task-specific demands, are "rather long-lived" (p. 1123) phenomena, i.e., are not restricted to the context that triggered the mindset but tune thought production in subsequent independent tasks. Based on these results, we analyzed "carry-over" effects of action crises. As an action crisis, through the process of reflecting on the personal goal (priming phase), is posited to elicit a

deliberative mindset that exists abstracted from the specific (goal) context, this cognitive orientation, in a mindset congruous direction, was assumed to transfer to subsequent unrelated (i.e., goal-independent) tasks. Evidence on "carry-over" effects would support the theory of an action crisis as a *post*decisional *deliberative* action phase that differs from the *volitional* (i.e., implemental and actional) action phases defined within mindset theory (Gollwitzer, 1990, 2012). However, in contrast to Gollwitzer et al. (1990), we applied a quasi-experimental approach as (deliberative vs. implemental) mindsets were not experimentally induced through task requirements (deliberating on vs. planning a decision) but indirectly via goal activation. A deliberative mindset was hypothesized to become activated to the extent to which an action crisis was experienced in the respective personal goal (e.g., becoming a lawyer).

In light of the ubiquitous presence of (especially highly self-relevant) personal goals in people's everyday life (Moskowitz & Grant, 2009), one might reason that the deliberative way of processing information characteristic of an action crisis may transfer to a wide array of goal-independent cognitive processes (e.g., cognitive processes associated with other goals).

The present research. Following the methodological approach applied by H. Heckhausen and Gollwitzer (1987, Study 1) and Gollwitzer et al. (1990, Study 1), we analyzed in Study 1 (a) how the experience of an action crisis affects the contents of the spontaneous stream of *goal-related* thoughts (goal-specific mindset effect) and (b) whether changes in cognitive functioning, which are associated with an action crisis, have an effect on cognition in *goal-independent* tasks (goal-unspecific mindset effect). In Study 2, based on the results of Study 1, we explored (on a correlational basis) if individuals' goal systems offer evidence of a "contagion effect", i.e., if an action crisis with respect to a particular goal, after

having controlled for potential confounders, may be predicted by the extent to which an action crisis is experienced in other goals.

Statistical analyses. In the present manuscript, regression analyses were calculated using the IBM® SPSS® software (version 20; IBM® SPSS® Statistics Inc., Armonk, NY). In Study 1, owing to not ideally normally distributed dependent variables, all significant beta-weights were validated using bootstrap resampling. Therefore, additional bootstrap estimates, standard errors, *p*-values, and 95 percent bias-corrected confidence intervals are provided. To perform bootstrap analyses, which were based on 1'000 bootstrap samples, and model comparisons (Study 2), we applied the structural equation modeling technique with the IBM® SPSS® Amos software (version 20; IBM® SPSS® Statistics Inc., Armonk, NY) using the maximum-likelihood method.

Study 1

In Study 1, a student sample was selected. For all students, the pursuit of one's studies was defined as a (nomothetic) personal goal. This strategy ascertained that a highly self-relevant "Be" goal that reflects long-term career plans and, hence, is deeply connected to the self, was analyzed (cf. Carver & Scheier, 2005, p. 536; Wrosch, Scheier, Carver, & Schulz, 2003).

Study 1 consisted of two quasi-experiments that were separated by an interval of six weeks. At T1 (pre-study), in the middle of the semester, students were instructed to deliberate on their studies and, subsequently, completed a thought-sampling questionnaire (cf. H. Heckhausen & Gollwitzer, 1987). It was posited that an action crisis is characterized by an emphasized deliberative (goal) reflection (*goal-specific mindset effect*).

At the end of the semester (T2), students were at first required to deliberate on their studies (in the course of filling out a goal-related questionnaire consisting of 30 items). In the second part of the quasi-experiment, students were introduced to an alleged creativity task in

which three unfinished fairy tales had to be completed (cf. Gollwitzer et al., 1990). In line with research on procedural priming (Förster et al., 2009), we hypothesized students creative endings to the incomplete fairy tales to be influenced by the degree of experienced action crisis. It was postulated that experiencing an action crisis is mirrored by ascribing more deliberative efforts to the fairytale figures (*goal-unspecific mindset effect*).

At T2, the administration of a goal-related questionnaire, which aimed at inducing a systematic evaluation of one's studies, thus served as the priming phase. In students suffering from an action crisis, goal evaluation was hypothesized to result in the activation of a deliberative mindset (e.g., weighing pros and cons) that, consequently, should be transferred to the (ostensibly independent) task of completing fairy tales (Brandstätter & Schüler, 2013; Förster et al., 2009; Gollwitzer et al., 1990; Smith & Branscombe, 1987). Hence, we did not analyze procedural priming following an experimental manipulation of cognitive processes (e.g., deliberating a change decision versus planning the implementation of a personal project; cf. Gollwitzer et al., 1990), but, by instructing participants to evaluate a highly self-relevant personal goal, explored the effect of an *indirect* mindset induction (via goal activation). Therefore, as participants, in the priming phase, were merely required to complete a questionnaire and not to actively engage in an experimental procedure, the study design was not susceptible to demand effects (Bargh & Chartrand, 2000). The potential of the cognitive procedures, which were activated during goal evaluation (priming phase), to transfer to an independent task was increased by the "field character" of the study (i.e., the idiographic nature of personal goals).

From the fact that mental resources are limited (Baddeley, 1986; Norman & Bobrow, 1975) follows the conclusion that a preoccupation with the re-evaluation of a goal in an action crisis has to result in a reallocation of cognitive resources. An intensified deliberative reflection in individuals experiencing an action crisis (in the pre-study at T1), consequently,

should be associated with a compensatory reduction in cognitive effort (i.e., thoughts) devoted to the implementation of the goal. Successful goal pursuit, however, not merely requires thoughts related to the planning and enactment of the goal, but, equally important, monitoring processes (e.g., Carver & Scheier, 1990; Liberman & Dar, 2009; G. A. Miller, Galanter, & Pribram, 1960). Especially with long-term goals, which are pursued in constantly changing contexts, continuous goal monitoring, a prerequisite to the introduction of adaptations, constitutes an integral part of successful self-regulation (Carver & Scheier, 1998). Whereas Gollwitzer (1990, p. 59) acknowledged the potential benefits of post*actional* evaluation for *future* planning, monitoring processes *during* goal striving (i.e., post*decisional* evaluative processes) were neither subject to theoretical considerations nor empirical research (Achtziger & Gollwitzer, 2010).

Even though the deliberative and evaluative action phases differ with respect to the focus of information processing (goal setting vs. goal evaluation) and, furthermore, the evaluative cognitive orientation has not been studied empirically, both action phases "are expected to encompass motivational phenomena and processes in the classic sense of the term" (Gollwitzer, 2012, p. 528). Therefore, because motivational (high-level construal) and volitional (low-level construal; Trope & Liberman, 2010) processes are "independent of each other" (p. 419) and, owing to functional incompatibility, "cannot coexist" (Gollwitzer & Bayer, 1999, p. 420), we hypothesized the increase in deliberative thoughts in action crises to be at the cost of evaluative processes. Hence, in the pre-study at T1, for individuals experiencing an action crisis, we assumed increased deliberation to be associated with a compensatory decrease in evaluative processes.

The hypothesis of a redistribution of cognitive resources within motivational processes corresponds to the idea "that making a goal decision creates a rather durable commitment to pursue this goal" (Gollwitzer, 1990, p. 62), with the consequence that

hindrances to goal achievement lead to a phase of invigoration (Klinger, 1975), i.e., increases in effort and the employment of different means. Following the current theory that goal-related failure experiences, which may precede an action crisis, are succeeded by *increased* volitional efforts (Brunstein, 2000; see also Klinger, 1975), an action crisis was not posited to account for a reduction in the strength of the volitional mindset. This line of thought is supported by J. Heckhausen, Wrosch, and Schulz (2010, p. 39) who theorized that, in the course of goal pursuit, volitional efforts should remain unaffected by goal-*re*evaluation processes.

Method

Participants.

Of the 190 students of the University of Zurich, Switzerland, participating in the online study in the middle of (T1) and at the end of the winter term (T2), one student had to be excluded from the final sample (n = 189, 136 women, M_{age} = 25.98 years, SD_{age} = 7.21, age range: 19–61 years, 15 psychology students) due to non-compliance with the study instructions. Participants were recruited via an email that, on request, was delivered by an official e-mail distributor of the University of Zurich, Switzerland. In compensation for completing an online questionnaire at two time points, participants received a coupon of the value of €14 (approximately $18) of a popular mail-order company.

Research design at T1 (pre-study).

Goal-related thought production. After having deliberated on their studies for 90 seconds, participants were interrupted and instructed to report on their thoughts (*goal-specific mindset effect*). To prevent response bias, the task of reporting on their thoughts was not announced to the participants prior to the interruption. A valid recall of thoughts was facilitated by asking participants, following the procedure reported by H. Heckhausen and Gollwitzer (1987), to start with the retrieval of the most recent thought from short-term

memory (cf. Ericsson & Simon, 1993). Subsequently, the second most recent thought should be reported, to be followed by the first thought and every thought in between. Participants were provided with four separate empty fields to write down their thoughts in the required order.

Thoughts were scored according to a coding scheme with three different categories. The *deliberative category* (*M* = .87) was scored if a student (a) was weighing up pros and cons (e.g., of a pending decision), (b) was ruminating about a decision that has already been implemented, (c) was deliberating on the expectancy and desirability of the focal or alternative goals (e.g., alternative subject areas), or (d) was preoccupied with feelings of helplessness (cf. state orientation, Kuhl, 1994b, p. 11). Scoring the *volitional category* (*M* = 1.88) required participants (a) to think about the implementation of actions (e.g., planning processes) or (b) to develop a goal-related strategy. The volitional category, furthermore, drawing on Kuhl (1984, 1992, 2000), was scored if participants thoughts (c) aimed at up-regulating positive (i.e., self-motivation) or down-regulating negative affect (i.e., self-relaxation), as both strategies, ultimately, "should result in behavioral and volitional facilitation" (Baumann, Kaschel, & Kuhl, 2007, p. 241). The *evaluative category* (*M* = .65) included (a) conclusions about and evaluations of past decision, events, and actions as well as (b) the exploration of the corresponding implications (in the absence of implementation intentions, cf. above).

Interrater reliability was calculated based on 100 sentences that were coded by two independent blind raters. Cohen's kappa (Cohen, 1960) was 0.71 for the deliberative, 0.69 for the volitional, and 0.78 for the evaluative category, indicating substantial agreement for all three categories (Landis & Koch, 1977, p. 165).

Research design at T2.

Goal-independent thought production. To analyze peoples goal-independent thought production (*goal-unspecific mindset effect*), drawing on Gollwitzer et al. (1990), participants were asked to complete an alleged creativity test in which the dilemmatic beginning of three fairy tales had to be continued. Therefore, participants were provided with three empty fields to continue each fairy tale with three sentences. All three fairy tales were borrowed from Gollwitzer et al. (1990, p. 1121), whereby the first fairy tale read as follows:

> Once upon a time there was a king who loved the queen dearly. When the queen died, he was left with his only daughter. The widowed king adored the little princess who grew up to be the most beautiful maiden that anyone had ever seen. When the princess turned 15, war broke out and her father had to go to battle. The king, however, did not know of anyone with whom he could entrust his daughter while he was away at war. The king... (p. 1121)

Subjects' sentences were coded according to a coding scheme that was theoretically derived from mindset theory (Gollwitzer, 1990, 2012) and followed the examples provided by Gollwitzer et al. (1990, p. 1127). On condition that a sentence applied to the main character of the fairy tale, it could be coded for either the deliberative or volitional category. Coding the *deliberative category* required the main character to (a) deliberate on the dilemma, (b) asking for advice (e.g., a clairvoyant), or (c) to be troubled by a feeling of helplessness (cf. state orientation, Kuhl, 1994b, p. 11). The *volitional category* included (a) the planning and implementation of goal-directed actions, (b) actual goal-oriented behavior (e.g., negotiating a peace agreement), and (c) to issue orders (e.g., to knights) that aim at solving the dilemma. In case a sentence contained several parts, both (mutually exclusive) categories could be coded for different constituents. To determine interrater reliability, 100 sentences were coded by two independent blind raters. Cohen's kappa (Cohen, 1960) was

0.90 for the deliberative and 0.90 for the volitional category, indicating high agreement for both categories (Landis & Koch, 1977, p. 165). Owing to the inherent structure of fairy tales in general and especially of endings, which usually "require the main character to take action" (cf. Gollwitzer et al., 1990, p. 1122) for the fairy tale to receive a conclusion, on average, the sum of scores for the deliberative category was considerably lower (M = 1.44) than for the volitional category (M = 4.63). Per participant, on average, 3.31 (of total nine) sentences could *not* be assigned to one of the two categories.

Measures at T1 and T2.

Action crisis. The extent to which participants were experiencing an action crisis regarding their studies, at T1 and T2, was (prior to the thought-sampling and the fairy tales, respectively) assessed using the six-item (e.g., "I have doubts whether I should continue striving for my goal or disengage from it.") Action Crisis Scale (ACRISS; Brandstätter et al., in press; Brandstätter & Schüler, 2013), the items of which were slightly adapted for the present research question (e.g., "I have doubts whether I should continue my studies or drop out of university."). Items were rated on a scale ranging from 1 (no agreement) to 5 (very much agreement) (T1: M = 2.37, SD = .81; T2: M = 2.23, SD = .77; αs $\geq$ .80).

Control variables. As students, at the time of measurement (i.e., at T1 and T2), differed with respect to the stage of their studies (i.e., the distance to the goal or rather goal progress; cf. Forster, Higgins, & Idson, 1998) and, furthermore, were doing different degrees in different faculties, i.e., substantially varied in goal importance and investment (Kuhl, 2000; Muraven & Baumeister, 2000), these variables that may have had an effect on depth and intensity of the evaluation of one's studies (cf. Gollwitzer, 2012, p. 539) and, therefore, procedural priming, were considered as control variables. Furthermore, we controlled for *action vs. state orientation* (Kuhl, 1994a), a personality disposition highly relevant to self-regulation, because "the construct of state orientation overlaps with ... [the] deliberative

mindset (Gollwitzer, 1990)" (Kuhl, 1994b, p. 11) (cf. Tables 1 and 2).

Goal importance. Goal importance was assessed using a four-item instrument (e.g., "My studies are important to me.") with a Likert scale ranging from 1 (no agreement) to 5 (very much agreement) (T1: $M = 4.13$, $SD = .71$; T2: $M = 4.13$, $SD = .71$; $\alpha s \geq .80$).

Goal progress. Goal progress was (at T1) operationalized by both the number of semesters already studied at the university ($M = 6.70$, $SD = 5.24$) and to be spent to receive the master's degree ($M = 4.98$, $SD = 3.77$) ($r = -.09$, $p = .222$).

Goal investment. Participants had to estimate the percentage of time resources (from 1 to 100 percent) they were currently investing in the pursuit or their studies (T1: $M = 58.84$, $SD = 23.34$; T2: $M = 44.39$, $SD = 27.46$).

Action Orientation. Action orientation was measured (at T2) using the 24-item Action Control Scale (e.g., "When I must finish something soon: (a) I find it easy to get it done. (b) I have to push myself to get started.") (ACS-90; Kuhl, 1994a) ($\alpha = .75$).

Results

Results (i.e., the means) concerning goal importance and investment (cf. above) clearly indicated that studying provides an excellent example of a highly self-relevant goal. In view of the substantial amount of time invested in studying, the conclusion seems warranted that the cognitive orientation, which is associated with the pursuit of this goal, holds the potential to transfer to a wide array of goal-independent activities.

In the following, results are discussed separately for goal-related thought production (pre-study at T1) and goal-independent thought production (T2). The relationship between the extent to which participants were experiencing an action crisis (with respect to their studies) and goal-related thought production (T1) and goal-independent thought production (T2) was evaluated with hierarchical linear regression analyses, the results of which were validated using bootstrap resampling technique (see Tables 1 and 2).

Goal-dependent thought production. Because students, at T1, were in the middle of the semester, the majority of thoughts (M = 1.88), not surprisingly, referred to the implementation of the goal. As expected, an action crisis did not influence the amount of volitional thoughts (β = .05, p = .580), but was positively associated with deliberative reflection (β = .24, p = .007; bootstrap estimates: β = .24, SE = .088, p = .007 [C.I. .057/.412]), at the cost of evaluative processes (β = -.21, p = .004; bootstrap estimate: β = -.20, SE = .071, p = .009 [C.I. -.333/-.063]) (see Table 1). Thus, it may be concluded that increased goal-related deliberation in action crises is not associated with a compensatory reduction in volitional but evaluative processes that, especially with long-term goals, serve as an important information basis for the planning and enactment of the goal (Carver & Scheier, 1998).

Table 1

Hierarchical Multiple Regression Analyses Predicting Deliberative, Volitional, and Evaluative Thoughts in a Thought-Sampling Questionnaire From Action Crisis With Respect to One's Studies (Study 1 at T1)

	Deliberative thoughts		Volitional thougths		Evaluative thougths	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.10**		.13***		.39***	
Control variables[a]						
Step 2	.04**		.00		.03**	
Action crisis		.24**		.05		-.21**
Total R^2	.13***		.13***		.41***	
n	189		189		189	

[a]Control variables included action orientation, goal progress, goal investment, goal importance, and total number of codings.

**p < .01. ***p < .001.

Goal-independent thought production. As can be seen from Table 2, an action crisis, in line with the results from the prestudy at T1, was predictive of ascribing deliberative (β = .24, p = .006; bootstrap estimates: β = .24, SE = .089, p = .011 [C.I. .051/.396]) but not volitional (β = -.01, p = .958) efforts to the main character of the fairy tales to be completed in the goal-independent task. Answering questions regarding one's studies, to the extent to which an action crisis was experienced in the goal, resulted in the activation of a deliberative

mindset that "continued to be active and operate in the second task, without participants being aware of or intentionally choosing this mode of thought while writing the story endings" (Bargh & Chartrand, 2000, p. 266)

Table 2

Hierarchical Multiple Regression Analyses Predicting Deliberative and Volitional Efforts Ascribed to the Main Characters of the Three Fairy Tales From Action Crisis With Respect to One's Studies (Study 1 at T2)

	Deliberative efforts		Volitional efforts	
Predictor	ΔR^2	β	ΔR^2	β
Step 1	.06^{+}		.06^{+}	
Control variables[a]				
Step 2	.04**		.00	
Action crisis		.24**		-.01
Total R^2	.10**		.06	
n	189		189	

[a]Control variables included action orientation, goal progress, goal investment, goal importance, and number of words written.

$^{+}p < .10$. $^{**}p < .01$.

Discussion

An action crisis, as hypothesized, while giving rise to increased goal-specific deliberative reflection (pre-study at T1) and, one a more abstract level, a goal-unspecific deliberative mindset (T2), seems to have no impact on (at least the amount of) volitional thoughts.

The results of Study 1 not merely provide evidence on the thought structure of the goal-related mindset associated with an action crisis but, more importantly, on potential mechanisms (i.e., procedural priming) by which an action crisis may impact cognitive processes in an array of goal-independent activities.

Study 2

Based on the results of Study 1, which lend support to the hypothesis that an action crisis in one goal may transfer to other goals, we conducted Study 2. On a correlational basis, we attempted to obtain evidence of a "contagion effect" of action crises in individuals' goal systems. If action crises indeed transfer to other goals, an action crisis in a particular goal, to

some degree, should, over and above the effect of goal characteristics and personality dispositions (i.e., even after having controlled for potential confounders), be predictable by the extent to which action crises are experienced in other goals.

In the present study, for mainly two reasons, several goal-relevant constructs were measured and considered as control variables. Firstly, we attempted to preclude the possibility that the prediction of an action crisis in one goal by (the overall degree of) action crises in other goals may be ascribed to a personality disposition (relevant to goal striving and goal disengagement). Secondly, we aimed at evaluating the incremental predictive value of (the overall degree of) action crises within a goal system over and above goal-characteristics that have previously been shown to be associated with the experience of an action crisis (Brandstätter et al., in press). These goal characteristics (e.g., goal self-concordance, cf. below), moreover, may be highly correlated between two goals within the same context, especially if the two (e.g., academic) goals serve the same superordinate goal (e.g., becoming a physician), and, if not controlled for, could partly account for an action crisis in one goal being predictive of the extent of action crises in other goals (of the same context).

As procedural priming is free of semantic content and *not* context-specific, conclusive evidence of a "contagion effect" would be provided if it was shown that a predictive effect is not restricted to a specific area of life (e.g., academia). Therefore, participants were required to list two personally relevant academic and two leisure goals. Statistically, it was evaluated whether an action crisis with respect to a particular goal may be predicted, *after* having controlled for the action crisis of the same context, by the extent to which action crises were experienced in the different context. In these analyses, action crises were averaged across the two goals of the different context (cf. Tables 3 to). As composite variables have better psychometric properties than individual variables, a composite measure (of the action crises regarding the two goals of the different context) was intended to compensate for the fact that

the predictive value of an action crisis is expected to be higher within the same context (e.g., owing to frequent co-occurrence).

Method

Participants.

Two hundred and four actual or former psychology students (162 women, M_{age} = 27.66 years, SD_{age} = 6.43, age range: 22-57 years) of the University of Zurich, Switzerland, participated in an online study after having been recruited by an email list of the department of psychology. Participants received a coupon of the value of €10 (approximately $13) of a popular mail-order company in compensation for completing an online questionnaire.

Measures.

Personal goals. Participants, after having read a description of the goal concept (Brunstein, 1993; Emmons, 1986), were instructed to list two personally relevant academic (or vocational[3]) and two leisure goals they were striving for (and intended to pursue in the near future).

Action crisis. Action crises regarding personal goals were assessed with the ACRISS (cf. Study 1; Brandstätter et al., in press; Brandstätter & Schüler, 2013) ($.75 \leq \alpha \leq .80$). For statistical analyses, action crises were averaged across the two academic and two leisure goals, respectively (cf. above).

Control variables.

Goal attainability. Participants rated goal attainability (item: "I think chances are high that I'm going to attain this goal.") on a scale ranging from 1 (no agreement) to 5 (very much agreement).

Goal desirability. Goal desirability (item: "This goal is important to me."), for every personal goal, was assessed on a scale ranging from 1 (no agreement) to 5 (very much agreement).

Goal progress. For the two academic and two leisure goals, participants were asked to indicate the subjective level of progress in percent (1 = "no goal progress at all"; 100 = "full goal progress").

Goal self-concordance. Goal self-concordance was assessed with the four-item self-concordance scale (Sheldon & Elliot, 1999). Personal goals had to be rated (on a nine-point scale from 1 = "no true at all" to 9 = "totally true") with respect to four reasons (i.e., *external*, *introjected*, *identified,* and *intrinsic* motivation) representing "a continuum of *perceived locus of causality* for behavior (Ryan & Connell, 1989), ranging from noninternalized to completely internalized" (Sheldon & Elliot, 1999, p. 486). A self-concordance index was built by subtracting the introjected and external scores from the identified and intrinsic scores (Sheldon & Elliot, 1999). Reliability was only mediocre ($\alpha \leq .45$) for academic goals and considerably low for leisure goals ($\alpha \leq .27$) what, presumably, is attributable to the fact that even highly self-concordant academic goals (e.g., "I want to understand statistics.") and leisure goals (e.g., "I want to quit smoking.") are frequently, to some extent, imposed by the social (e.g., family) or academic (e.g., curriculum) context.

Goal adjustment capacities. Goal adjustment capacities (i.e., goal disengagement and goal reengagement), as having been proven to be highly relevant to adaptive self-regulation (e.g., coping), especially in stressful circumstances that may give rise to the development of an action crisis (e.g., Wrosch, Amir, & Miller, 2011), in the present study, were identified as potential dispositional predictors of action crises. Goal disengagement and reengagement capacities were assessed with a four-item and six-item questionnaire, respectively, introduced and validated by Wrosch and colleagues (e.g., G. E. Miller & Wrosch, 2007; Wrosch & Miller, 2009; Wrosch, Scheier, Miller, Schulz, & Carver, 2003). Following the generic term "If I have to stop pursuing an important goal in my life...", participants indicated how they usually react (goal disengagement: e.g., "I stay committed to the goal for a long time. I can't

let it go.", α = .85; goal reengagement: e.g., "I convince myself that I have other meaningful goals to pursue.", α = .91) when they are forced to stop pursuing an important personal goal (Wrosch, Scheier, Miller, et al., 2003, p. 1197).

Results

To address our research question, we performed, for each goal separately, a hierarchical linear regression analysis, whereby the experienced action crisis was regressed upon goal-related control variables (step 1), personality dispositions (step 2), and action crises in the three other goals (step 3). In step 3, we separately entered the action crisis with respect to the goal of the same context and the composite measure of the action crises regarding the two goals of the different context. Therefore, in step 3 of the regression analyses, we evaluated whether, as hypothesized, the predictive value of an action crisis with respect to a particular goal for the action crises experienced in other goals is not a context-specific phenomenon. As an action crisis was associated with a goal-*un*specific deliberative mindset in Study 1, a "contagion effect" should not be limited to a specific context (e.g., academia) (see Tables 3 to 6).[4]

Table 3

Hierarchical Multiple Regression Analysis Predicting Action Crisis With Respect to Academic Goal 1 From Action Crises Regarding Academic Goal 2 and Leisure Goals (Study 2)

	Action crisis academic goal 1	
Predictor	ΔR^2	β
Step 1	.35***	
Control variables[a]		
Step 2	.02^{+}	
GAT		
Step 3	.07***	
Action crisis academic goal 2		.25***
Action crisis leisure goals		.11^{+}
Total R^2	.44***	
n	204	

Note. GAT = goal adjustment tendencies. For leisure goals, values are averaged over the two goals.

[a]Control variables included desirability, attainability, progress, and self-concordance of academic goal 1.

$^{+}p < .10$. ***$p < .001$.

Table 4

Hierarchical Multiple Regression Analysis Predicting Action Crisis With Respect to Academic Goal 2 From Action Crises Regarding Academic Goal 1 and Leisure Goals (Study 2)

	Action crisis academic goal 2	
Predictor	ΔR^2	β
Step 1	.31***	
Control variables[a]		
Step 2	.05***	
GAT		
Step 3	.08***	
Action crisis academic goal 1		.24***
Action crisis leisure goals		.13*
Total R^2	.43***	
n	204	

Note. GAT = goal adjustment tendencies. For leisure goals, values are averaged over the two goals.

[a]Control variables included desirability, attainability, progress, and self-concordance of academic goal 2.

*p < .05. ***$p < .001$.

Table 5

Hierarchical Multiple Regression Analysis Predicting Action Crisis With Respect to Leisure Goal 1 From Action Crises Regarding Leisure Goal 2 and Academic Goals (Study 2)

	Action crisis leisure goal 1	
Predictor	ΔR^2	β
Step 1	.37***	
Control variables[a]		
Step 2	.02^{+}	
GAT		
Step 3	.07***	
Action crisis leisure goal 2		.16**
Action crisis academic goals		.19**
Total R^2	.45***	
n	204	

Note. GAT = goal adjustment tendencies. For academic goals, values are averaged over the two goals.

[a]Control variables included desirability, attainability, progress, and self-concordance of leisure goal 1.

$^{+}p < .10$. $^{**}p < .01$. $^{***}p < .001$.

Table 6

Hierarchical Multiple Regression Analysis Predicting Action Crisis With Respect to Leisure Goal 2 From Action Crises Regarding Leisure Goal 1 and Academic Goals (Study 2)

	Action crisis leisure goal 2	
Predictor	ΔR^2	β
Step 1	.47***	
Control variables[a]		
Step 2	.02*	
GAT		
Step 3	.07***	
Action crisis leisure goal 1		.19***
Action crisis academic goals		.16**
Total R^2	.56***	
n	204	

Note. GAT = goal adjustment tendencies. For academic goals, values are averaged over the two goals.

[a]Control variables included desirability, attainability, progress, and self-concordance of leisure goal 2.

*p < .05. **p < .01. $^{***}p < .001$.

With exception of the action crisis in the second leisure goal (cf. Table 5), on a descriptive level, action crises could be better predicted by the action crisis of the same context than the averaged action crises of the different context. This pattern of results could be explained by the fact that the probability for priming effects to last is dependent on the co-

occurrence of two goals (i.e., the pursuit of one goal is followed by the pursuit of the other goal) that may be increased within a specific context. However, when the two corresponding paths (cf. step 3, Tables 3 to 6), in each of the four regression analyses, were set to equality using structural equation modeling, model comparisons in all four analyses ($\Delta df = 1$, $\Delta X^2 \leq 1.4$, all $ps \geq .24$) indicated non-significant differences between the context-specific and -*un*specific effect (Byrne, 2010). The, on a mere descriptive level, generally increased size of the beta-weights of action crises regarding academic goals may be attributable to the typically exceptionally large amount of time invested in academic goals (cf. Study 1) and the fact that academic goals ($M = 4.63$, $SE = 0.04$) were assessed to be more important ($t(203) = 5.60$, $p < .001$, $r = .37$) than leisure goals ($M = 4.36$, $SE = 0.04$) in Study 2.

Discussion

Even though the results, due to the cross-sectional and correlational nature of the data, should be interpreted with reserve, the consistent pattern across the four personal goals of two different contexts supports the idea of a (goal-*un*specific) "contagion effect". However, in spite of considering an adequate number of control variables and the, consequently, substantial amount of explained variance (cf. Tables 3 to 6), we cannot exclude the possibility that a (e.g., dispositional) variable, which was not measured in the present study, explains the shared variance of action crises in different goals.

General Discussion

Study 1, which consisted of two quasi-experiments, was conducted following the methodological procedure described by H. Heckhausen and Gollwitzer (1987, Study 1) and Gollwitzer et al. (1990, Study 1). As a first step (pre-study at T1), we analyzed the effects of an action crisis on the spontaneous *goal-related* stream of thought (*goal-specific mindset*) and, as a second consecutive step (at T2), evaluated how the way of processing information characteristic of an action crisis, by procedural priming, transfers to *goal-independent* cognition (*goal-unspecific mindset*). In Study 2, we tested, based on the idea of a "contagion effect", to which extent an action crisis in a particular goal may be predicted by the degree to which action crises are experienced in other goals, after having controlled for goal-relevant control variables.

In Study 1, at T1 (pre-study), we found an action crisis to result in a trade-off between deliberative reflection and evaluative processes, whereas the amount of volitional thoughts remained unaffected by the intra-psychic goal conflict. This finding corresponds to the idea, which originated from mindset theory (e.g., Achtziger & Gollwitzer, 2010), that, once a goal intention has been formed, the volitional mindset is unaffected by *post*decisional deliberation on the goal (J. Heckhausen et al., 2010; Nenkov & Gollwitzer, 2012). The assumption, however, that "once a decision is made, further deliberative reflection is precluded" (H. Heckhausen & Gollwitzer, 1987, p. 103), could not be supported by the present results. Although the *total* amount of cognitive effort devoted to the implementation of a goal seemed to have remained constant in an action crisis, this did not apply to the *relative* proportion of volitional (to deliberative) thoughts, whereby the functionality of the resulting cognitive orientation, with respect to goal pursuit, may have become impaired. Contrary to this reasoning, one could argue, with recourse to the terminology of mindset theory (Gollwitzer, 2012), that the relative proportion of volitional to motivational (i.e., deliberative *and*

evaluative) thoughts was unaffected by the experience of an action crisis. In this line of argument, however, the fact is ignored that deliberative and evaluative (i.e., monitoring) processes, with respect to goal pursuit, are functionally different. Especially with long-term goals, continuous evaluation, in contrast to *post*decisional deliberation, serves as an informational basis for volitional processes and, thereby, constitutes a prerequisite to improvement and the implementation of adaptations (Carver & Scheier, 1998). Initial evidence for the idea that a trade-off between deliberative and evaluative processes, which results from an action crisis, may affect volitional functionality has been provided by Brandstätter and Schüler (2013, Study 2) who reported effects of action crises on recognition in incidental learning. In an experimental scenario study, "action crisis participants showed a significantly weaker memory advantage for implementation-related over cost–benefit-related material in comparison to non-action crisis participants" (p. 547).

The idea that an individual's cognitive functioning is altered in action crises is, moreover, strongly supported by the procedural priming effects found at T2 in Study 1. Even though at T2, as at T1, volitional efforts (ascribed to the fairytale figure) were unaffected by the degree of experienced action crisis, an action crisis was positively associated with a goal-unspecific deliberative mindset. This mindset shift, in line with research reported by Brandstätter and Schüler (2013, Study 2), supports the hypothesis that an action crisis affects the functionality of the volitional mindset. We therefore arrived at the conclusion that the "qualitative leap" (H. Heckhausen & Gollwitzer, 1987, p. 103), which results from forming a goal intention, is, to some extent, counterbalanced in an action crisis. However, even though an action crisis is characterized by increased goal-specific deliberative reflection as well as a goal-unspecific deliberative mindset, results of Study 1 (at T1 and T2) clearly indicate that the cognitive orientation (in an action crisis) remains predominantly volitional. This seems to be the logical consequence when considering that an action crisis, by definition, emerges

while a goal is being pursued. Thus, as long as an action crisis is not resolved, an individual is "doing the splits" between deliberating on and pursuing a goal.

Research on how *goal priming* (Moskowitz & Gesundheit, 2009) affects the pursuit of personal goals has provided ample evidence on "the capacity of the human mental system to adapt flexibly to the environment" (Förster et al., 2009, p. 188). However, whereas goal priming serves a self-regulatory function, this does not apply to *procedural priming*, the role of which in the pursuit of personal goals has, so far, not been subject to systematic scientific analysis. In the present manuscript we, correspondingly, did *not* focus on (automatic and dynamic) self-regulatory mechanisms within goal systems (i.e., goal priming; cf. Kruglanski et al., 2002), but on the question as to what extent the pursuit of goals in everyday life, independent of aspects of functionality and semantic content, may be influenced by procedural priming effects. More precisely, we explored (in Study 1 at T2) whether cognitive procedures, which have been activated in the course of thinking about a particular goal, affect the way of processing information in subsequent tasks not related to the initial context. Thus, instead of experimentally manipulating cognitive procedures through task instructions (cf. Gollwitzer et al., 1990), we analyzed the effect of interindividual differences regarding the extent of experienced action crisis on goal-independent thought production. By examining *indirect* procedural priming effects, which are attributable to the mere activation of a personal goal, we pursued a methodologically new and thereby theory-building approach. To our knowledge, indirect procedural priming effects through the mere activation of personal goals have not been theoretically or empirically analyzed. The present results indicate that a procedural priming perspective may advance our understanding of the influence of goals on human cognition and behavior.

From a methodological perspective, the present results provide evidence that "having participants complete questionnaires prior to another dependent measure can be a major source of ... priming effects" (Bargh & Chartrand, 2000, p. 267).

Whereas the ecological validity of the results is increased by the field character of the studies (i.e., the analysis of idiographic goals), inferences about causality, due to the quasi-experimental or cross-sectional study designs, are *not* warranted. The present line of research, therefore, may be continued and complemented with experimental studies. Whether it is possible to experimentally reproduce the far-reaching consequences associated with an action crisis (in a personal goal) in a laboratory setting, needs to be evaluated in future research.

Potentially *adverse* consequences of procedural priming effects, which are of particular interest for the present line of research, have been described by Schooler (2002; Schooler et al., 1997). According to *processing shift theory* (Schooler, 2002; Schooler et al., 1997), a *transfer inappropriate shift* occurs if the processing requirements of a subsequent task conflict with the primed procedures. Transfer inappropriate shifts, therefore, may account for "functional handicap[s]" (H. Heckhausen & Gollwitzer, 1987, p. 119), defined by the incompatibility of activated cognitive procedures and situational requirements. As individuals, in everyday life, constantly switch between different goals (e.g., calling one's spouse from work), it seems therefore highly probable that an action crisis, which may (to some extent) transfer to other goals by procedural priming, leads to a functional handicap. How an action crisis could result in a functional handicap may be illustrated by the following example. One might imagine the situation in which a student, who is seriously questioning her/his subject of study, after having attended a class, goes out on a date. Whereas the present research aimed at providing an answer to the question if this student, on the way to her/his date, is at increased risk of analyzing the pros and cons for meeting the other person (i.e., questioning her/his decision to arrange a date), future research may evaluate whether a goal-

unspecific deliberative mindset, which has been activated by an action crisis experienced regarding one's studies, compromises volitional strategies on how to enchant one's date.

References

Achtziger, A., & Gollwitzer, P. M. (2010). Motivation and volition in the course of action. In J. Heckhausen & H. Heckhausen (Eds.), *Motivation and action* (2nd ed., pp. 275-299). New York, NY: Cambridge University Press.

Baddeley, A. (1986). *Working memory*. New York, NY US: Clarendon Press/Oxford University Press.

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology.* (pp. 253-285). New York, NY US: Cambridge University Press.

Baumann, N., Kaschel, R., & Kuhl, J. (2007). Affect sensitivity and affect regulation in dealing with positive and negative affect. *Journal of Research in Personality*, *41*(1), 239-248. doi: http://dx.doi.org/10.1016/j.jrp.2006.05.002

Brandstätter, V., Herrmann, M., & Schüler, J. (in press). The struggle of giving up - Affective, physiological, and cognitive consequences of an action crisis. *Personality and Social Psychology Bulletin.*

Brandstätter, V., & Schüler, J. (2013). Action crisis and cost–benefit thinking: A cognitive analysis of a goal-disengagement phase. *Journal of Experimental Social Psychology, 49*, 543-553. doi: 10.1016/j.jesp.2012.10.004

Brunstein, J. C. (1993). Personal goals and subjective well-being: A longitudinal study. *Journal of Personality and Social Psychology, 65*(5), 1061-1070. doi: http://dx.doi.org/10.1037/0022-3514.65.5.1061

Brunstein, J. C. (2000). Motivation and performance following failure: The effortful pursuit of self-defining goals. *Applied Psychology: An International Review, 49*(3), 340-356. doi: 10.1111/1464-0597.00019

Byrne, B. M. (Ed.). (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge.

Carver, C. S., & Scheier, M. F. (1990). Origins and functions of positive and negative affect: A control-process view. *Psychological Review, 97*(1), 19-35. doi: http://dx.doi.org/10.1037/0033-295X.97.1.19

Carver, C. S., & Scheier, M. F. (1998). *On the self-regulation of behavior*. New York, NY: Cambridge University Press; US.

Carver, C. S., & Scheier, M. F. (2005). Engagement, Disengagement, Coping, and Catastrophe. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation.* (pp. 527-547). New York, NY US: Guilford Publications.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*, 37-46. doi: 10.1177/001316446002000104

Emmons, R. A. (1986). Personal strivings: An approach to personality and subjective well-being. *Journal of Personality and Social Psychology, 51*(5), 1058-1068. doi: http://dx.doi.org/10.1037/0022-3514.51.5.1058

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data (rev. ed.).* Cambridge, MA: The MIT Press.

Forster, J., Higgins, E., & Idson, L. C. (1998). Approach and avoidance strength during goal attainment: Regulatory focus and the "goal looms larger" effect. *Journal of Personality and Social Psychology, 75*(5), 1115-1131. doi: http://dx.doi.org/10.1037/0022-3514.75.5.1115

Förster, J., Liberman, N., & Friedman, R. S. (2009). What do we prime? On distinguishing between semantic priming, procedural priming, and goal priming. In E. Morsella, J. A. Bargh & P. M. Gollwitzer (Eds.), *Oxford handbook of human action.* (pp. 173-192). New York, NY US: Oxford University Press.

Friedman, R. S., Fishbach, A., Förster, J., & Werth, L. (2003). Attentional priming effects on creativity. *Creativity Research Journal, 15*(2-3), 277-286. doi: 10.1207/s15326934crj152&3_18

Fujita, K., Trope, Y., & Liberman, N. (2006). The Role of Mental Construal in Self-Control. In D. De Cremer, M. Zeelenberg & J. K. Murnighan (Eds.), *Social psychology and economics.* (pp. 193-211). Mahwah, NJ US: Lawrence Erlbaum Associates Publishers.

Gollwitzer, P. M. (1990). Action phases and mind-sets. In T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 53-92). New York, NY: Guilford Press; US.

Gollwitzer, P. M. (2012). Mindset theory of action phases. In P. Lange, A. W. Kruglanski & T. E. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 526-545). Thousand Oaks, CA: Sage Publications Ltd.

Gollwitzer, P. M., & Bayer, U. (1999). Deliberative versus implemental mindsets in the control of action *Dual-process theories in social psychology* (pp. 403-422). New York, NY: Guilford Press; US.

Gollwitzer, P. M., Heckhausen, H., & Steller, B. (1990). Deliberative and implemental mind-sets: Cognitive tuning toward congruous thoughts and information. *Journal of Personality and Social Psychology, 59*(6), 1119-1127. doi: http://dx.doi.org/10.1037/0022-3514.59.6.1119

Gollwitzer, P. M., & Kirchhof, O. (1998). The willful pursuit of identity. In J. Heckhausen & C. S. Dweck (Eds.), *Motivation and self-regulation across the life span* (pp. 389-423). New York, NY: Cambridge University Press.

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion, 11*(2), 101-120. doi: http://dx.doi.org/10.1007/BF00992338

Heckhausen, J., Wrosch, C., & Schulz, R. (2010). A motivational theory of life-span development. *Psychological Review, 117*(1), 32-60. doi: http://dx.doi.org/10.1037/a0017668

Herrmann, M., Baur, V., Brandstätter, V., Hänggi, J., & Jäncke, L. (2013). *Being in two minds: The neural basisi of experiencing action crises in personal goals*. Manuscript submitted for publication.

Herrmann, M., & Brandstätter, V. (2013). *Action Orientation Promotes health and well-being by preventing and overcoming action crises in personal goals*. Manuscript submitted for publication.

Kirmani, A., Lee, M. P., & Yoon, C. (2004). Procedural priming effects on spontaneous inference formation. *Journal of Economic Psychology, 25*(6), 859-875. doi: 10.1016/j.joep.2003.09.003

Klinger, E. (1975). Consequences of commitment to and disengagement from incentives. *Psychological Review, 82*(1), 1-25. doi: http://dx.doi.org/10.1037/h0076171

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 331-378). San Diego, CA: Academic Press.

Kuhl, J. (1984). Volitional aspects of achievement motivation and learned helplessness: Toward a comprehensive theory of action control. In B. A. Maher (Ed.), *Progress in experimental personality research* (Vol. 13, pp. 99-171). New York, NY: Academic Press.

Kuhl, J. (1992). A theory of self-regulation: Action versus state orientation, self-discrimination, and some applications. *Applied Psychology: An International Review, 41*(2), 97-129. doi: http://dx.doi.org/10.1111/j.1464-0597.1992.tb00688.x

Kuhl, J. (1994a). Action versus state orientation: Psychometric properties of the Action Control Scale (ACS-90). In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action versus state orientation* (pp. 47-59). Göttingen, Germany: Hogrefe.

Kuhl, J. (1994b). A theory of action and state orientation. In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action versus state orientation* (pp. 9-46). Göttingen, Germany: Hogrefe.

Kuhl, J. (2000). A functional-design approach to motivation and self-regulation: The dynamics of personality systems interactions. In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 111-169). San Diego, CA: Academic Press.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159-174.

Liberman, N., & Dar, R. (2009). Normal and pathological consequences of encountering difficulties in monitoring progress toward goals. In G. B. Moskowitz & H. Grant (Eds.), *The psychology of goals.* (pp. 277-303). New York, NY US: Guilford Press.

McNamara, T. P. (2005). *Semantic priming: Perspectives from memory and word recognition*. New York, NY US: Psychology Press.

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*. New York, NY US: Henry Holt and Co.

Miller, G. E., & Wrosch, C. (2007). You've gotta know when to fold 'em: Goal disengagement and systemic inflammation in adolescence. *Psychological Science, 18*(9), 773-777. doi: http://dx.doi.org/10.1111/j.1467-9280.2007.01977.x

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning & Verbal Behavior, 16*(5), 519-533. doi: 10.1016/s0022-5371(77)80016-9

Moskowitz, G. B., & Gesundheit, Y. (2009). Goal priming. In G. B. Moskowitz & H. Grant (Eds.), *The psychology of goals.* (pp. 203-233). New York, NY US: Guilford Press.

Moskowitz, G. B., & Grant, H. (2009). *The psychology of goals*. New York, NY: Guilford Press.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*(2), 247-259. doi: http://dx.doi.org/10.1037/0033-2909.126.2.247

Nenkov, G. Y., & Gollwitzer, P. M. (2012). Pre- versus postdecisional deliberation and goal commitment: The positive effects of defensiveness. *Journal of Experimental Social Psychology, 48*(1), 106-121. doi: 10.1016/j.jesp.2011.08.002

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology, 7*(1), 44-64. doi: 10.1016/0010-0285(75)90004-3

Schooler, J. W. (2002). Verbalization produces a transfer inappropriate processing shift. *Applied Cognitive Psychology, 16*(8), 989-997. doi: 10.1002/acp.930

Schooler, J. W., Fiore, S. M., & Brandimonte, M. A. (1997). At a loss from words: Verbal overshadowing of perceptual memories. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory, Vol. 37.* (pp. 291-340). San Diego, CA US: Academic Press.

Sheldon, K. M., & Elliot, A. J. (1999). Goal striving, need satisfaction, and longitudinal well-being: The self-concordance model. *Journal of Personality and Social Psychology, 76*(3), 482-497. doi: http://dx.doi.org/10.1037/0022-3514.76.3.482

Smith, E. R., & Branscombe, N. R. (1987). Procedurally mediated social inferences: The case of category accessibility effects. *Journal of Experimental Social Psychology, 23*(5), 361-382. doi: 10.1016/0022-1031(87)90036-9

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review, 117*(2), 440-463. doi: http://dx.doi.org/10.1037/a0018963

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247*(4940), 301-306. doi: 10.1126/science.2296719

Wrosch, C., Amir, E., & Miller, G. E. (2011). Goal adjustment capacities, coping, and subjective well-being: The sample case of caregiving for a family member with mental illness. *Journal of Personality and Social Psychology, 100*(5), 934-946. doi: http://dx.doi.org/10.1037/a0022873

Wrosch, C., & Miller, G. E. (2009). Depressive symptoms can be useful: Self-regulatory and emotional benefits of dysphoric mood in adolescence. *Journal of Personality and Social Psychology, 96*(6), 1181-1190. doi: http://dx.doi.org/10.1037/a0015172

Wrosch, C., Scheier, M. F., Carver, C. S., & Schulz, R. (2003). The importance of goal disengagement in adaptive self-regulation: When giving up is beneficial. *Self and Identity, 2*(1), 1-20. doi: http://dx.doi.org/10.1080/15298860309021

Wrosch, C., Scheier, M. F., Miller, G. E., Schulz, R., & Carver, C. S. (2003). Adaptive Self-Regulation of Unattainable Goals: Goal Disengagement, Goal Reengagement, and Subjective Well-Being. *Personality and Social Psychology Bulletin, 29*(12), 1494-1508. doi: http://dx.doi.org/10.1177/0146167203256921

Notes

[1]In the terminology of mindset theory of action phases (Gollwitzer, 1990, 2012; H. Heckhausen & Gollwitzer, 1987), the consecutive path of action may be subdivided in four functionally distinct action phases, whereby, on a higher level of abstraction, the first (i.e., deliberative or predecisional) and the last (i.e., evaluative or postactional) phase are conceptualized as *motivation* and the intermediate (i.e., postdecisional/implemental and actional) phases as *volition*. However, even though both the deliberative and evaluative phase are hypothesized to be characterized by a motivational mindset, the two associated tasks (i.e., goal setting vs. goal evaluation), with respect to goal pursuit, are functionally different. Volitional processes, in contrast, are functionally homogenous as both volitional action phases are directed at the translation of goals into action. In the present manuscript, for clarity's sake, we therefore attempted to avoid the term *motivational* to refer to the deliberative mindset.

[2]In the present manuscript, for the sake of conceptual clarity, we intentionally avoided using the term *mindset priming* as a subcategory of procedural priming. Mindset priming, in scientific literature, has been used to explain psychological phenomena that, in the terminology of Förster et al. (2009), would have been classified under semantic and/or goal priming.

[3]Participants (n =15) who were not studying at the time of measurement were asked to list two vocational goals. However, the two subgroups did not significantly differ with respect to any study variables. Therefore, for brevity's sake, we referred exclusively to academic goals in the remaining part of the manuscript.

[4]Additional explorative analyses did not reveal any significant interaction effects.

CURRICULUM VITAE

NAME: Marcel Herrmann

DATE OF BIRTH: 1984 - September 8th

HOME TOWN: Bowil (Berne)

OFFICE ADDRESS: Department of Psychology, University of Zurich
Binzmuhlestrasse 14/6, CH-8050 Zurich
Phone: +41/44/635 72 29
Fax: +41/44/635 75 19
E-mail: m.herrmann@psychologie.uzh.ch

PRIVATE ADDRESS: Veilchenstrasse 19, CH-8032 Zurich
Phone: +41/79/562 78 81
E-mail: mherrm@outlook.com

EDUCATION: Diploma in Psychology (Master of Science), University of Zurich, Department of Psychology, 2010

MASTER'S THESIS: Herrmann, M. (2009). *Die Bedeutung der Motivkonstellation für die psychobiologische Stressreaktion in Gruppen (TSST-G)* [Implicit motives, explicit motives, and the psychobiological stress response in groups (TSST-G)]. Unpublished master's thesis, Department of Psychology, University of Zurich, Zurich, Switzerland.

PROFESSIONAL POSITIONS AND WORKING EXPERIENCE:

Laboratory Assistant, Zentrum für Schlafmedizin / Schlaflabor Fluntern [Sleep Medicine Centre, Zurich] (Director: Dr. med. A. Ben-Shmuel), (2007-2010)

Internship, Psychiatrische Universitätsklinik Zürich [Psychiatric University Hospital Zurich] (5/2009-10/2009)

PhD Student, Department of Psychology, University of Zurich (2010-2013)